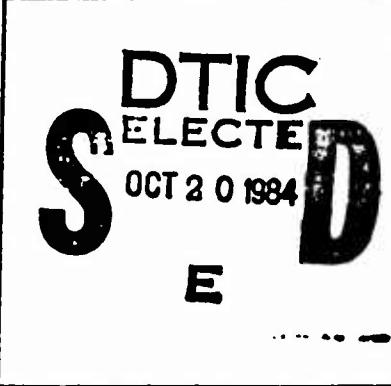


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REPORT NO. 110/860

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COLLIMATION OF BALLISTIC PROPERTIES OF LIGHT ARMOR PLATE

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IS NOT TO BE RELEASED WITHOUT PRIOR
APPROVAL OF COMMANDING OFFICER.
WILSON REED, WATERTOWN 72, MASS.



E. L. Reed
Research Metallurgist

J. M. Druegel
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Report No. 710/250
Watertown Arsenal

January 26, 1938

CORRELATION OF BALLISTIC PROPERTIES OF LIGHT ARMOR PLATE

Purpose

The purpose of this investigation is to correlate existing ballistic properties of light armor plate in reply to a request from the Ordnance Office, as of O.O. 400.114/16794 Misc., dated May 14, 1937.

Introduction

A copy of the specific requests in the above letter is given below:

- (a) Should we continue to use face hardened plate in all thicknesses?
- (b) Should the ballistic limit for face hardened plate be raised, and if so, how much?
- (c) Should we continue to offer a bonus for face hardened plate?
- (d) (1). Should the ductility test be made more severe, for example, by requiring the testing of all plates with 37 lb. shot as is now done for heavier plates?
(2). Considering difficulties of manufacture, relative cost, and greater facility of war procurement, would it not be desirable to obtain homogeneous plate. If so, should this be done for all thicknesses of plate or only for plates above a certain thickness? (This question

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predicated on the results obtained at Aberdeen, indicating that as the thickness of plate increases, homogeneous plate approaches the face hardened plate in resistance and then exceeds it.)

- (e) If homogeneous plate be used, could it be fastened by welding at the seams? If so, what reduction in protection at the seams could be expected?

Conclusions

Results are based upon the correlation of ballistic data taken from,

- (a) Aberdeen Partial Reports on Test of Thin Armor Plate, Ordnance Program No. 4334 T.S.T.P. No. 1922-107, dated 1922 to date.
- (b) Aberdeen letter reports on tests of experimental plate submitted by various manufacturers, dated December 9, 1936 to date.

A. Face hardened plate (carburized) can be continued in all thicknesses. Reference - Figs. 2 to 8, incl. and Tables No. 1 and No. 2.

B. The ballistic limit of carburized plate can be raised in excess of Tentative Specifications AXS-54K, dated April 19, 1937, as follows (see also Fig. 1):

Proposed Specification

<u>Thickness (Inches)</u>	<u>Bullet</u>	<u>Impact Velocities Required Minimum f.s. ± 15 f.s.</u>	
1/4"	.250	Cal. .30 A.P. M1922	1900
5/16"	.312	"	2050
3/8"	.375	"	2200
7/16"	.437	"	2350
1/2"	.500	"	2500
9/16"	.562	Cal. .50 A.P. M1	2025
5/8"	.625	"	2125
11/16"	.687	"	2200
3/4"	.75	"	2300
7/8"	.875	"	2475
1"	1.00	"	2650
1 1/8"	1.125	"	2825
1 1/4"	1.25	"	2900

Shock tests (machine gun and 37 MM. impact) to remain same as AXS-54K.

C. No bonus should be offered for high quality carburized plate since high quality carburized plate is more easily obtained than homogeneous plate. In the last five years, only 26% of the homogeneous plate tested passed

specifications, whereas 74% of carburized and 77% of the nitrided plate passed specified limits (Tables No. 1 and 2).

D.(1) On the basis of the results in Aberdeen Report No. 102, no plate 5/8" thick or less can withstand an impact by a 37 MM. shot (see Table No. 3).

(2) In view of the varying ability of different manufacturers to produce good homogeneous plate, no statement can be made as to its rapid procurement during emergency (see Tables No. 4a, b, and c). However, when obtained from those manufacturers who can readily produce homogeneous plate, it can be used to as much advantage as face hardened plate for thicknesses 5/8" and greater (see Fig. 3).

It should be noted that Fig. 7 repeats the results found at Aberdeen, i.e. "as the thickness of plate increases, homogeneous plate approaches the face hardened plate in resistance and then exceeds it". However, Fig. 7 includes data only from 1922 to 1932. More recent data, Figs. 3 and 5, do not follow this trend.

E. The opinion of this Arsenal on the question of welding has been given in Watertown Arsenal letter, 400.114/5062 as of May 28, 1937, as noted:

"It can be stated at this time that, if the design will allow a projection of the order of one inch on the rear face of the plate at the seam, a joint can be made in homogeneous plate that will give the same or greater protection than the base plate. This joint design contemplates welding a strip of soft plate to the armor plate in the annealed condition and making the weld in the soft plate after the hardening operation. While we are working on the process of trying to develop a suitable weld material for welding the heat treated plate, it is very doubtful that we will succeed in securing an effective protection of the joint greater than 25% of that of the unwelded plate."

Procedure

The armor plate recorded in the Aberdeen reports was separated into homogeneous, carburized, and nitrided groups.

Each group was tabulated (Tables No. 5a, b, c) according to manufacturer, chemical composition, thickness, ammunition, specification, ballistic limit, Brinell hardness, and remarks describing spalling characteristics.

(a) Manufacturer. Tabulations were made on plates manufactured by Carnegie Steel Co., Crucible Steel Co., Diebold Safe and Lock Co., Henry Disston & Sons, Inc.,

Eddystone Steel Co., Halcomb Steel Co., Ludlum Steel Co., and Watertown Arsenal Experimental.

(b) Chemical Analysis. Wherever this was furnished by the manufacturer, his plates were segregated according to their chemical composition.

(c) Thickness. These were subdivided according to thickness as follows:

1/8"	- .125	included thicknesses from .094 - .156
3/16"	- .188	" " ".157 - .219
1/4"	- .25	" " ".220 - .281
5/16"	- .313	" " ".282 - .343
3/8"	- .375	" " ".344 - .406
7/16"	- .438	" " ".407 - .469
1/2"	- .500	" " ".470 - .532
9/16"	- .563	" " ".533 - .592
5/8"	- .625	" " ".593 - .687
3/4"	- .75	" " ".688 - .813
7/8"	- .875	" " ".814 - .938
1"	- 1.00	" " ".939 - 1.094
1 1/8"	- 1.125	" " " 1.095 - 1.188
1 1/4"	- 1.25	" " " 1.189 - 1.313

(d) Ammunition. These thicknesses were subdivided according to the caliber of shot:-

(1) Caliber .30 A.P. M1922

(2) Caliber .50 A.P. M1

A special table (No. 3) was made covering the impact by 37 MM. A.P. solid shot, M .39, weight 1.45 pounds.

(e) Specifications. These were redivided according to the specification under which the ballistic limit was determined.

- (1) 150 ft. range - used from Aug. 10, 1922 to Jan. 29, 1932.
- (2) Spec. No. 31 - " " Jan. 29, 1932 to July 25, 1933.
- (3) AXS-54 Rev. 1 - " " July 25, 1933 to Dec. 17, 1934.
- (4) AXS-54 Rev. 2 - " " Dec. 17, 1934 to June 1, 1936.
- (5) AXS-54 Rev. F, H, K, - used from June 1, 1936 to date.

(f) Ballistic Limit. The ballistic limit was tabulated in foot-seconds.

(g) Brinell Hardness. The Brinell hardness was also recorded.

(h) Remarks. Spalling characteristics of the plates were determined by a careful study of the photographs in the Aberdeen Reports whenever these were furnished.

The data so obtained were treated in the following manner:

Arithmetic averages of the ballistic limits and Brinell hardnesses for each grouping of each manufacturer were taken. (Table 6a, b, c).

From these arithmetic means, an optimum average was determined by arbitrarily eliminating all plate (up to 50% of the total number of plates) whose ballistic limits fell more than 100-foot seconds below the arithmetic mean (Tables 6a, b, c).

From this optimum average, the specification averages of Cal. .30 and Cal. .50 impacts were determined by the additional elimination of all brittle plate. However, in the case of 37 MM. plot (Fig. 8), ballistic limits of brittle plate were used to determine the curve since all plate attacked by 37 MM. shot showed evidence of brittleness.

In this case, the deviations of the mean and the weight of the average were determined by the usual statistical methods. (Tables 6a, b, c).

In addition, the percentage of the total number of individual plates which passed the specifications applying to that plate was calculated as well as the per cent brittleness. (Tables 6a, b, c).

For the purpose of plotting graphs Nos. 2 to 8, a weighted mean of the specification averages of the ballistic limits including all manufacturers and all chemical composition for each thickness and each specification, found in Tables 6a, b, c, was determined and is listed in Tables 7a, b, c.

These graphs (Figs. 2 to 8) were used in rating the ballistic efficiency of carburized, homogeneous and

nitrated plates, as well as in the determination of the proposed specification. (Graphs 1, 2, 3).

Tables of ballistic efficiencies of the plate of each manufacturer and of each composition and thickness were drawn up (Tables 2a, b, c). These data were taken from Tables 6a, b, c.

From these tables, brief summaries were made, showing the performance of homogeneous, face hardened, and nitrated plate for different periods of time (Table 2); for various thickness (Table 1); and for various manufacturers (Table 4a, b, c).

Table 9 was taken directly from the Aberdeen Reports and plotted in Graphs 9 and 10.

Table 10a, b, c, were taken from Aberdeen Report No. 12 and plotted in Fig. No. 11a, b, c.

Table No. 11 shows the chemical compositions furnished by various manufacturers and is a resume of information contained in Table 5.

Results of Investigation

A comparison of ballistic efficiency of homogeneous, carburized, and nitrated plate for the last five years is given in Table 1.

Graphical representation of the proposed specification

and the Specification AXS-54-K, K-1, is shown in Fig. 1.

Figs. 2, 3, 4, 5, 6, 7, and 8 represent ballistic limits of homogeneous and nitrided plates under various specifications, 1922 - 1936.

Table 3 shows the ballistic results of 37 MM. solid shot impact.

Table 4 shows a summary of ballistic efficiency of homogeneous carburized and nitrided plate for various periods of time.

Summaries of ballistic efficiencies of homogeneous, carburized, and nitrided plates for various manufacturers and periods are shown in Tables 4a, b, c.

The performance of each manufacturer's carburized plate for the last five years shows that Diebold plate passes specifications 100%. However, this plate is only experimental and not produced commercially.

The Disston carburized plate passes 76% and Carnegie passes only 42%.

Within the last year, Diebold and Disston plate, carburized, passed specifications 100%, but it is noted that plates of these companies were experimental.

In regard to the homogeneous plate, Disston is the only company who has supplied such plate. In the last five years, only 25% of Disston homogeneous plate has passed, but in the last year, 75% of experimental plate passed.

TABLE 1
**Comparison of Ballistic Efficiency of Homogeneous,
Carburized and Nitrided Plate for the Last Five Years**

<u>Thickness</u>	<u>Homogeneous</u>	<u>% Pass</u>	<u>Carburized</u>	<u>Nitrided</u>	<u>Homogeneous</u>	<u>% Brittle</u>	<u>Carburized</u>	<u>Nitrided</u>
3/16" .188	0	-	-	-	0	-	-	-
1/4" .25	0	77	83	54	9	17	-	-
5/16" .312	-	100	-	-	0	-	-	-
3/8" .375	0	54	50	63	27	0	-	-
7/16" .438	-	100	100	-	8	0	-	-
1/2" .500	25	82	76	29	0	0	-	-
9/16" .563	-	100	-	-	0	-	-	-
5/8" .625	50	100	-	25	0	-	-	-
3/4" .75	0	50	-	100	50	-	-	-
7/8" .875	100	-	-	0	-	-	-	-
1" 1.00	0	100	-	100	0	-	-	-

Note: That the % of homogeneous plate that passes increases with increasing thickness.

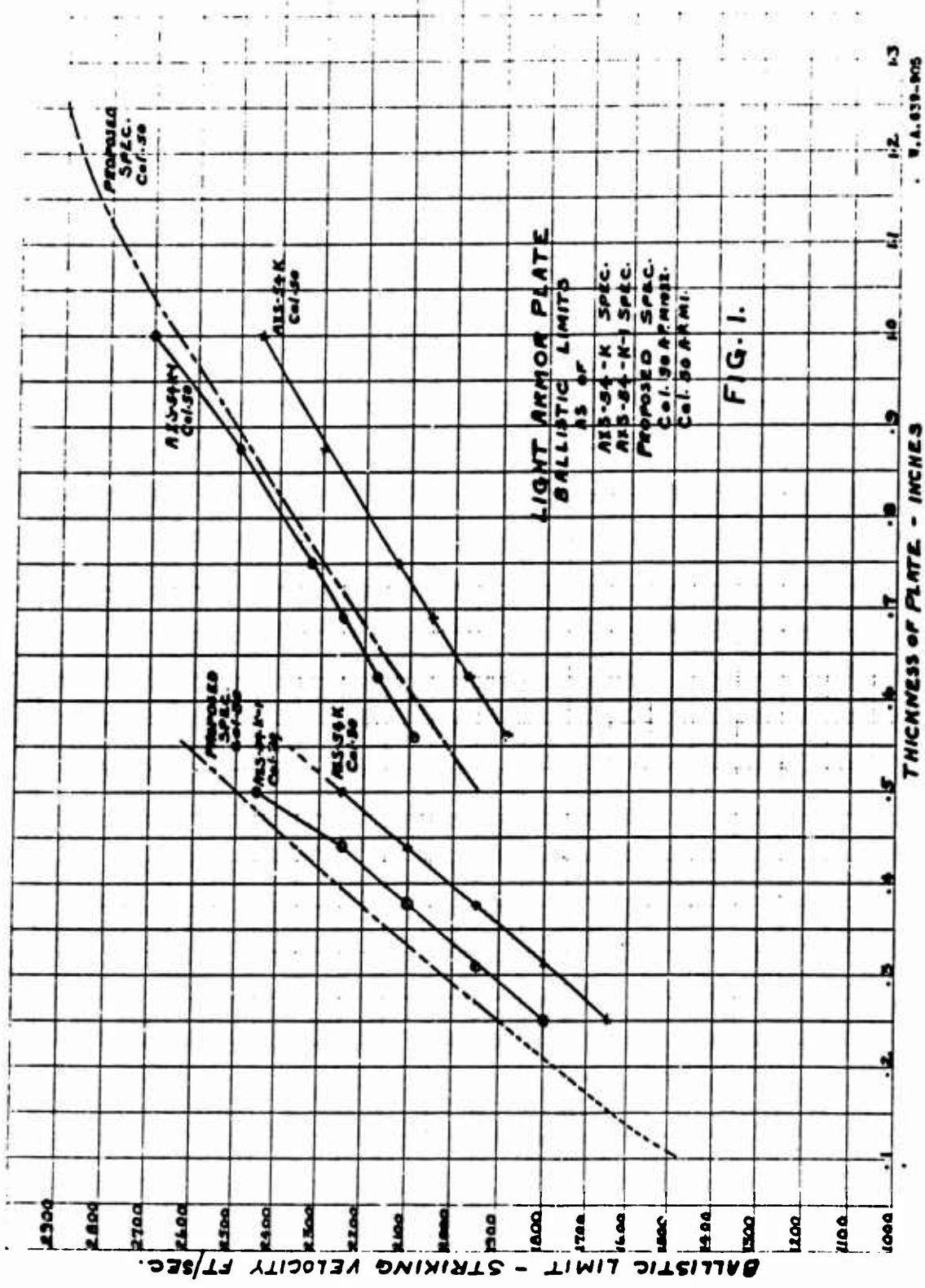


FIG. I.

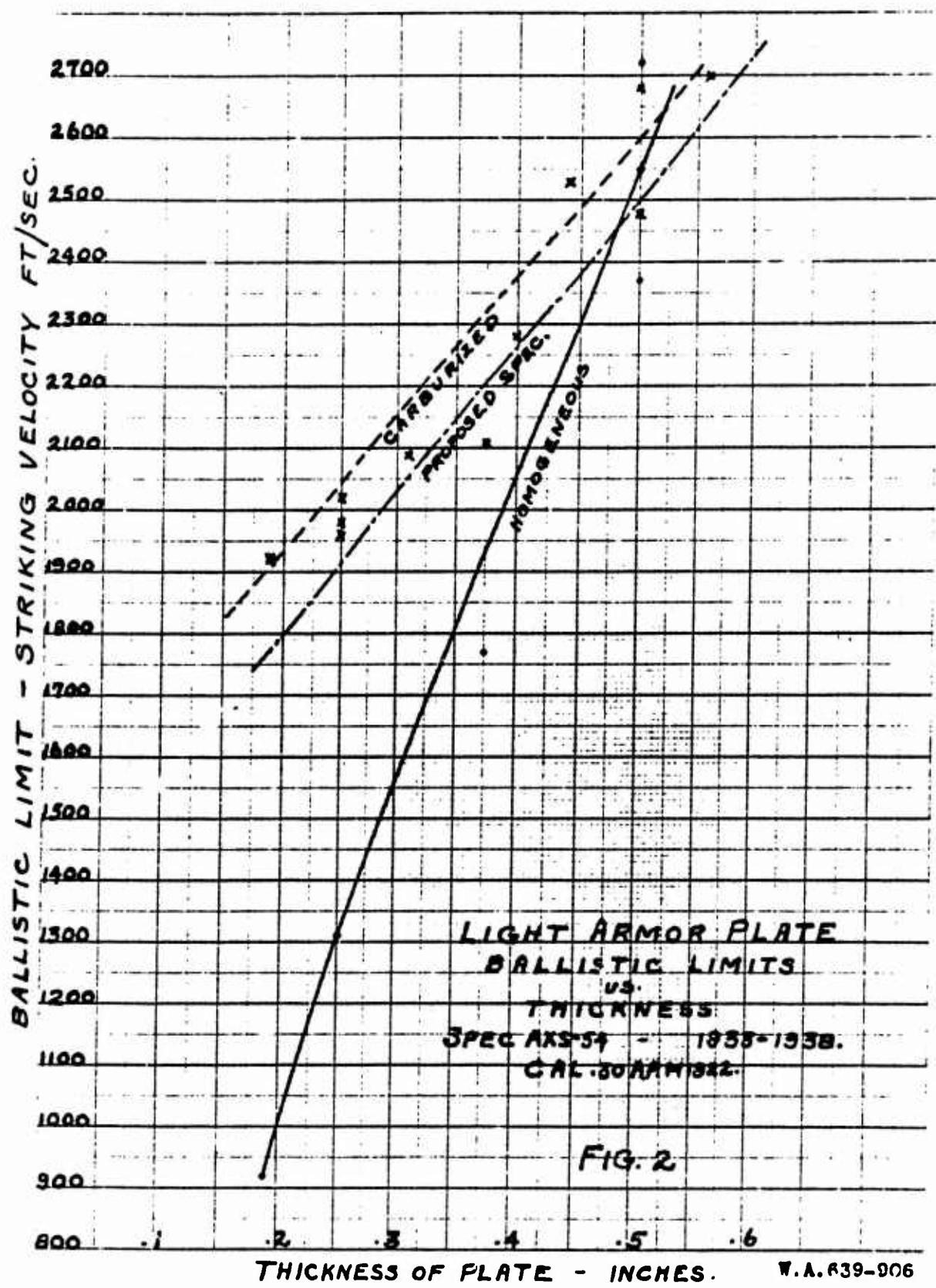
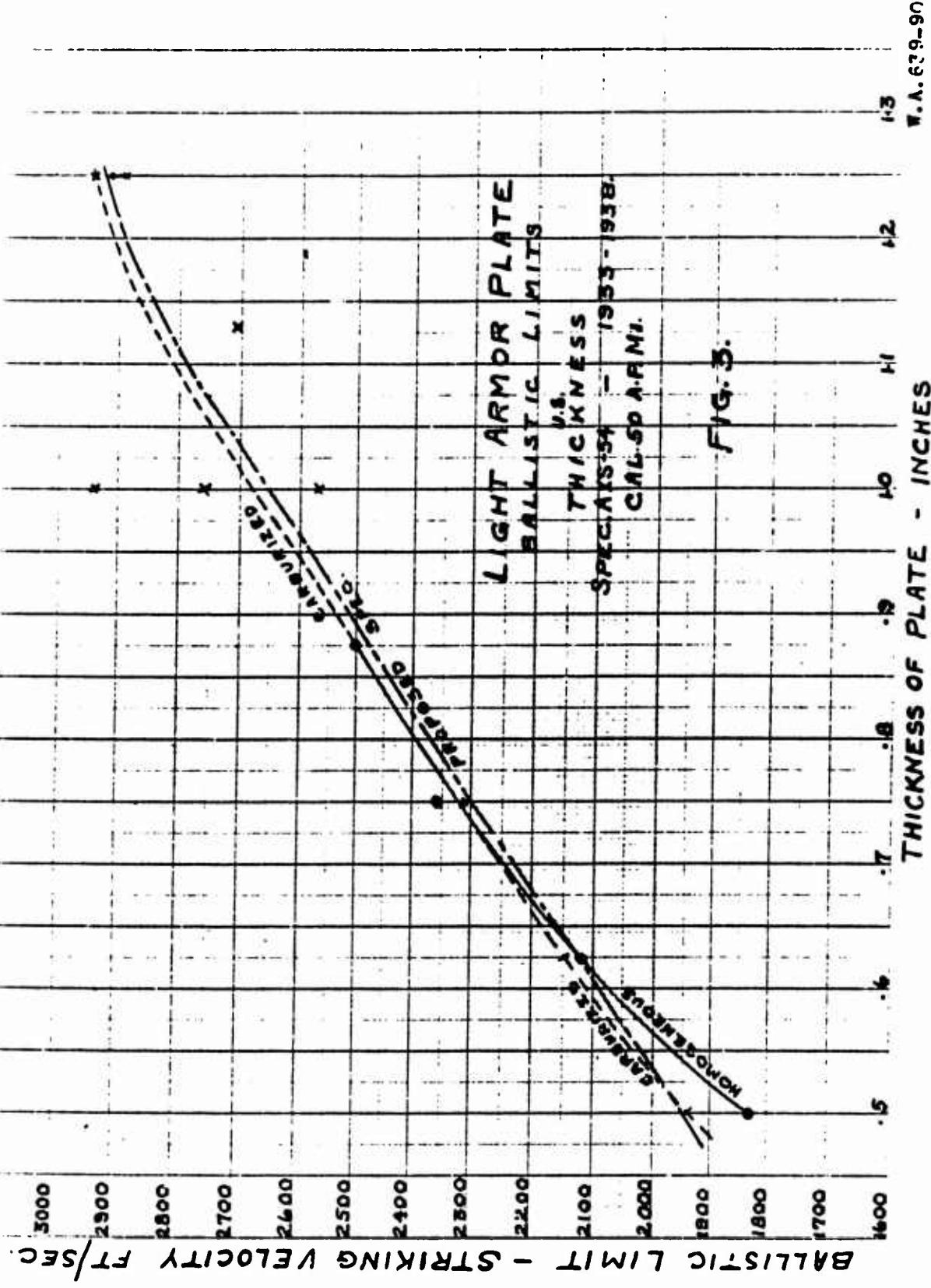
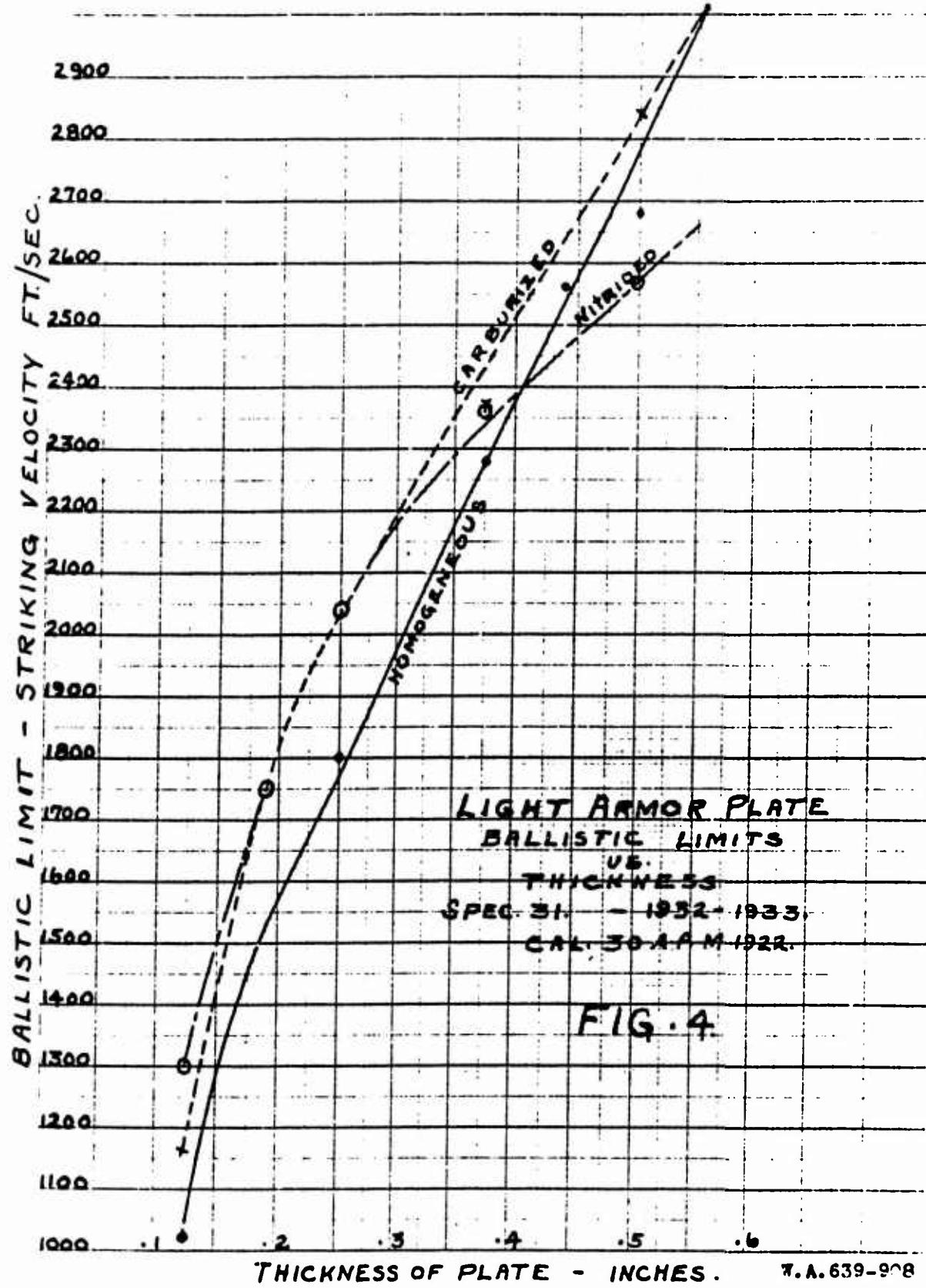
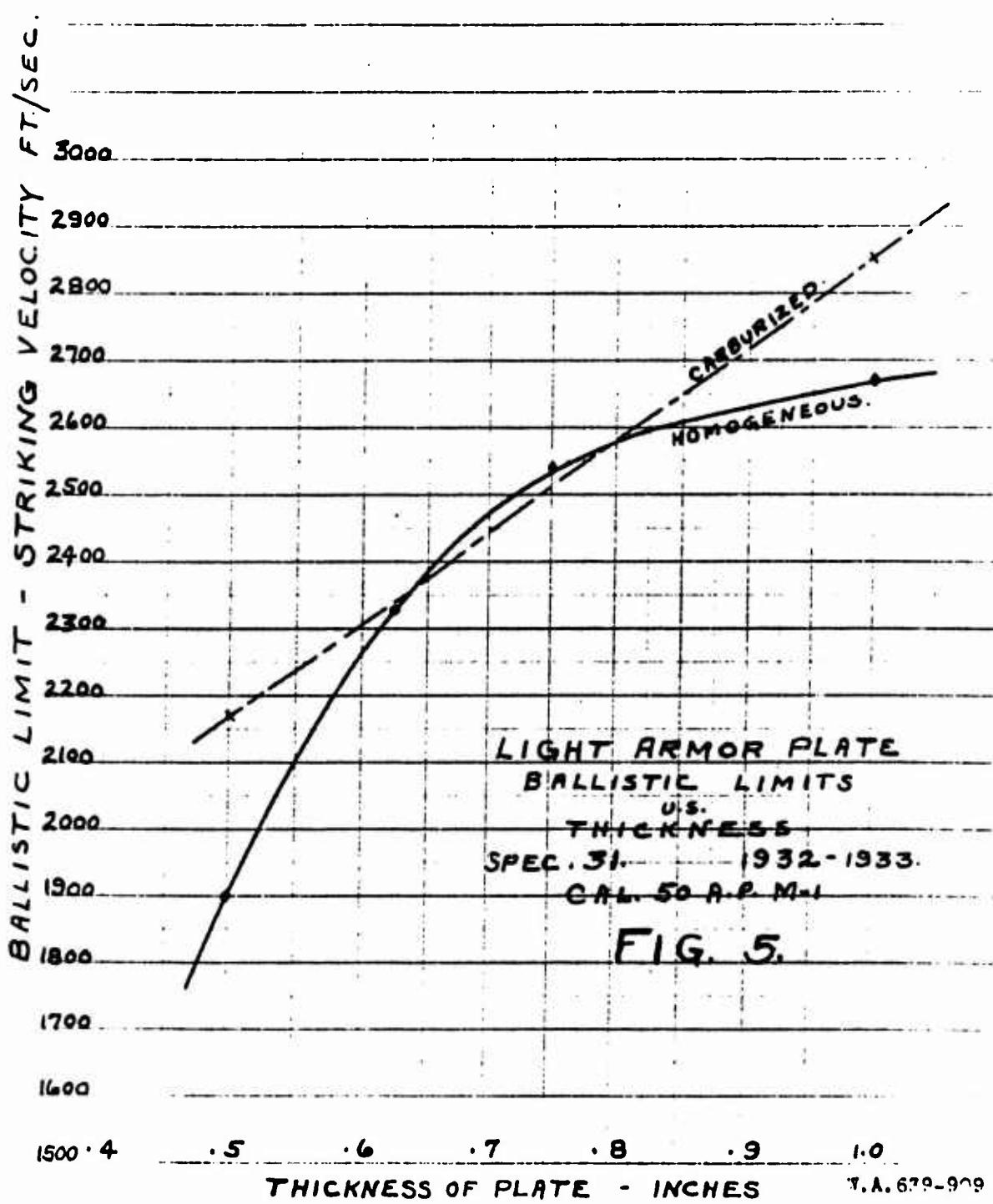
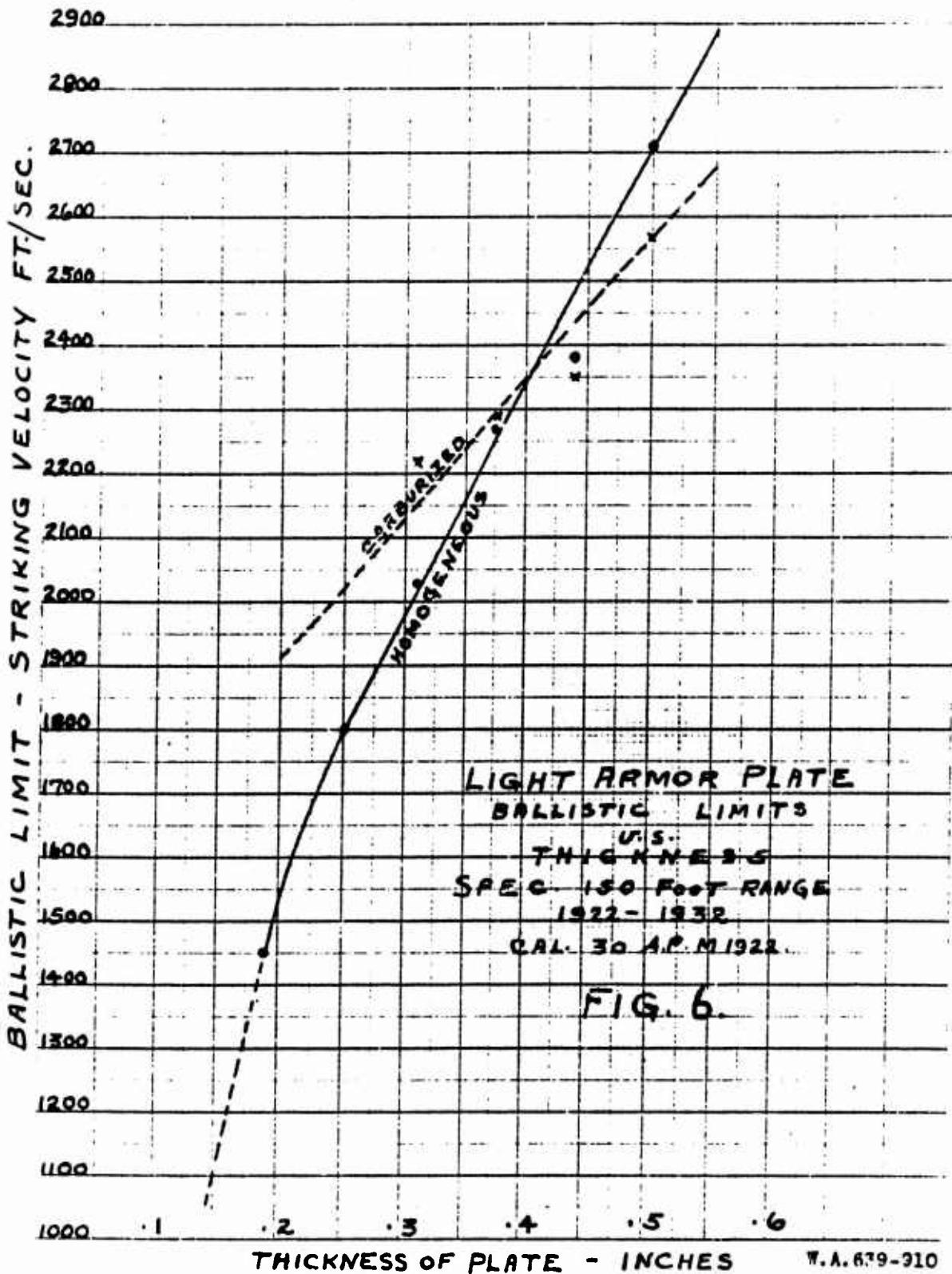


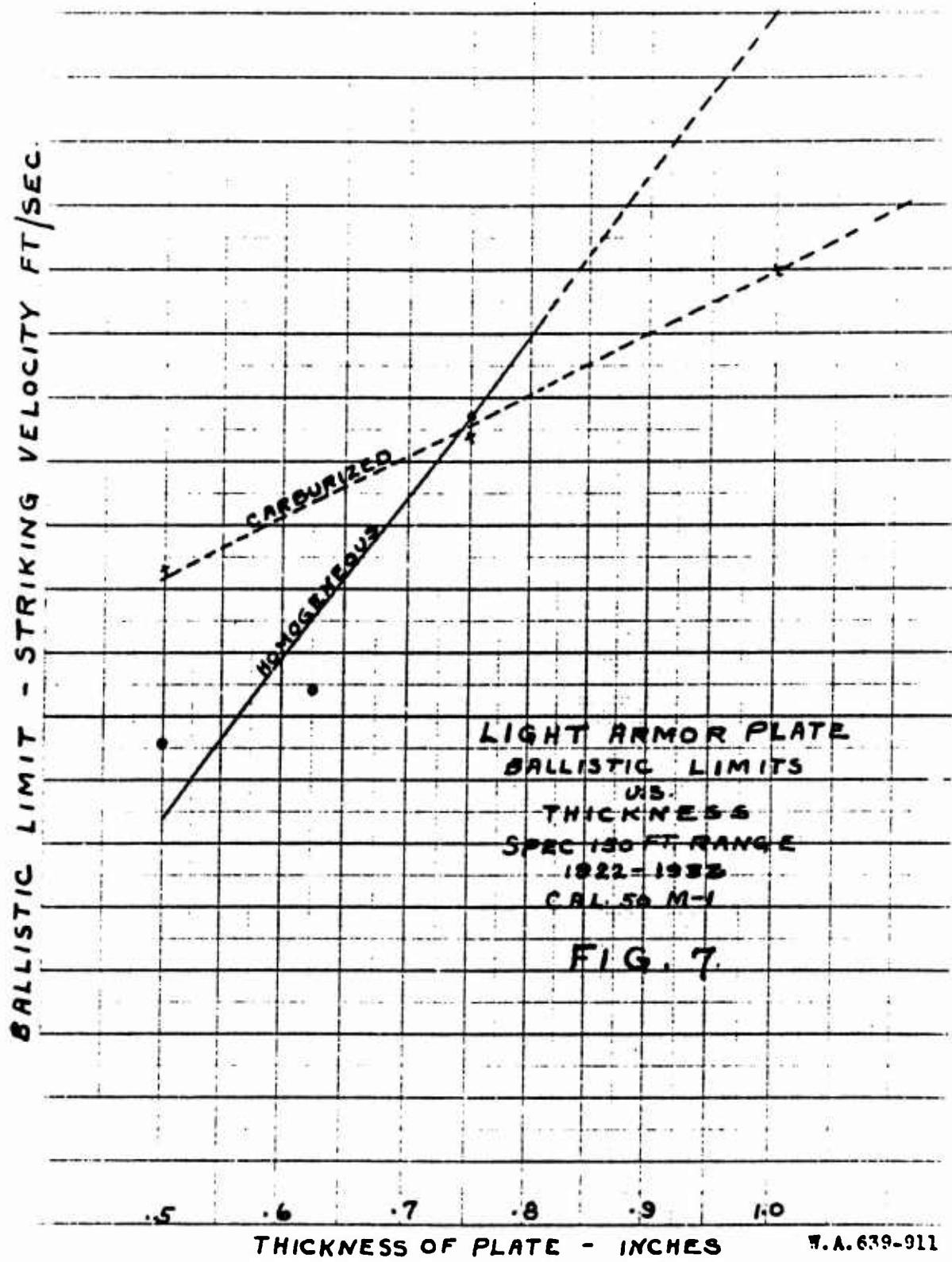
FIG. 3.











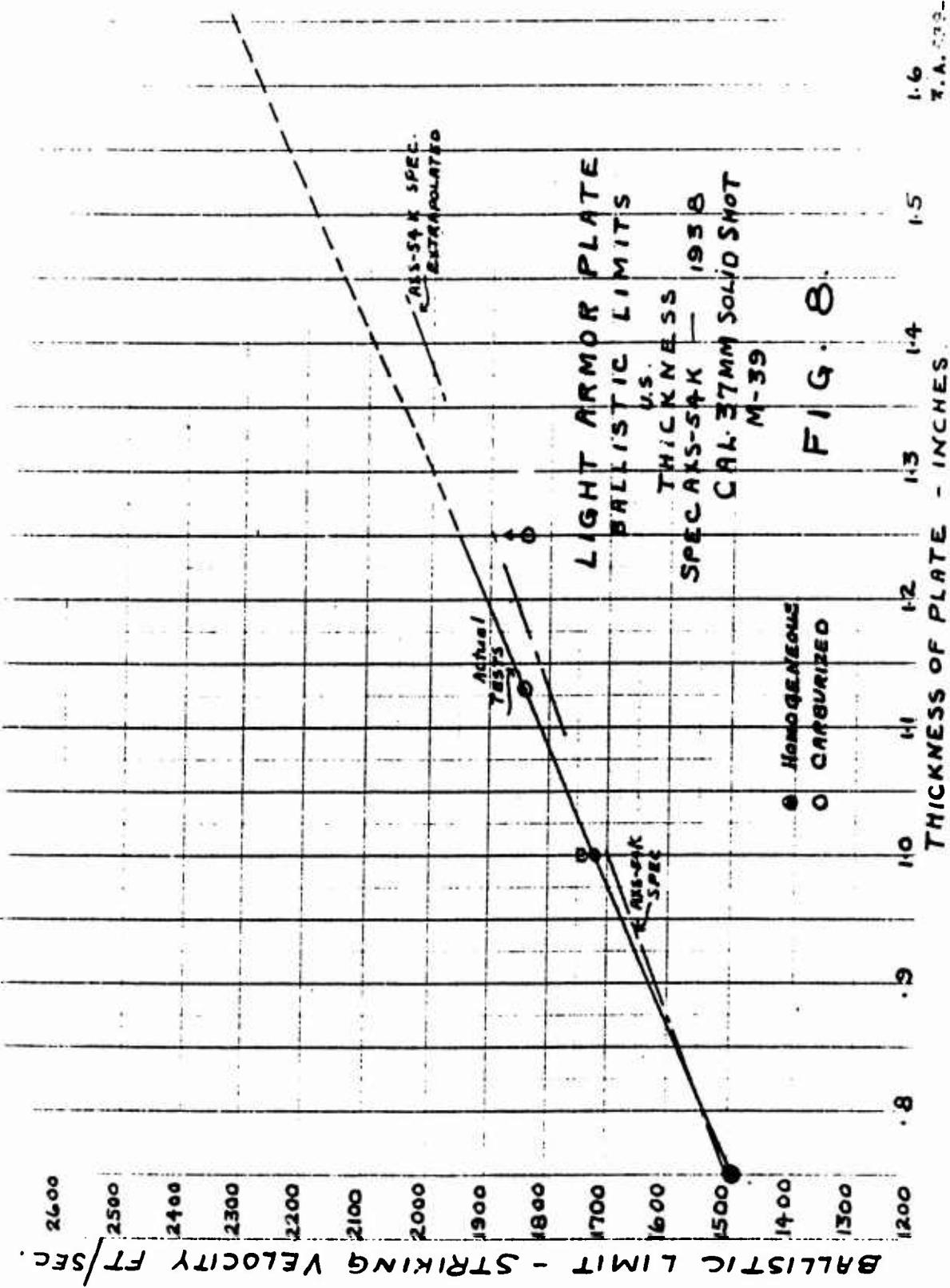


TABLE 2

Summary of Ballistic Efficiency of Homogeneous, Carburized and
Nitrided Plate for Various Periods of Time

	<u>% Pass</u>	<u>Homogeneous</u>	<u>Carburized</u>	<u>Nitrided</u>	<u>% Brittle</u>	<u>Homogeneous</u>	<u>Carburized</u>	<u>Nitrided</u>
Last 16 yrs.	36	57	61	37	30	37	30	17
Last 5 yrs.	26	74	77	45	13	13	4	-
Last year	75	100	-	-	13	0	-	-

TABLE 3

37 mm. Shell - M39 1.45 lb.

<u>Manufacturer</u>	<u>Thickness</u>	<u>Spec.</u>	<u>Ballistic</u>	<u>Remarks</u>
DIEBOLD (Face Hardened)	1" 1.00	AXS-54 -F	1715	
	1 1/8" 1.13	AXS-54 -F	1844	Complete <u>near</u> previous penetrations.
DISSTON (Homogeneous)	3/4" .75	AXS-54 -K	1485	Slight spall.
			1495	" "
			1490	Average
(Face Hardened)	1/4" .25			Cracked both faces front hole 4.3" rear hole 2.2"
	1/2" 5.00			Large circular cracks front hole 5.5" rear hole 1.6"
	5/8" .625			Section broke off front when fired at on the rear. Circular cracks on front. Long star cracks on rear. Front hole 6.1"
	1" 1.00	AXS-54 -H	1722	4" button
			1723	
			1723	Average
	AXS-54 -2		1737	6" button
	1 1/4" 1.25		1840	Partial buttons and cracks.

TABLE 4 (a)

Summary of Ballistic Efficiency of Homogeneous Plate
for Various Manufacturers and Periods

<u>Manufacturer</u>	<u>% Pass</u>	<u>% Brittle</u>	<u>Years</u>	<u>Spec.</u>
Crucible	29	48	'22 - '32	150
	0	100	'32 - '33	31
Dissston	81	10	'22 - '32	150
	83	11	'32 - '33	31
	1	40	'33 - '34	Rev. 1
	1	83	'34 - '36	Rev. 2
	75	13	'36	Rev. F, H, K
Eddystone	0	0	'22 - '32	150
	76	24	'32 - '33	31

TABLE 4 (b)

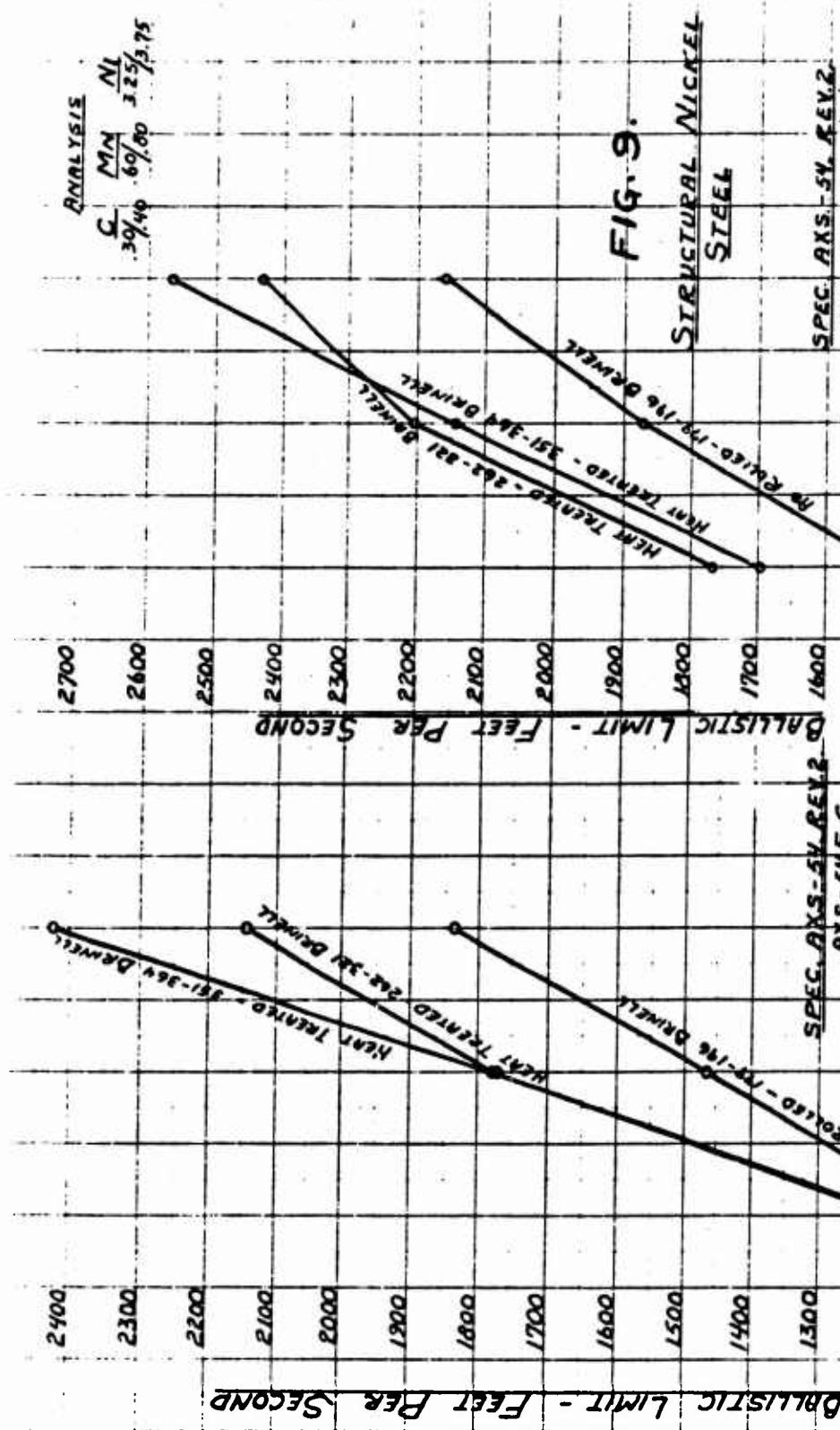
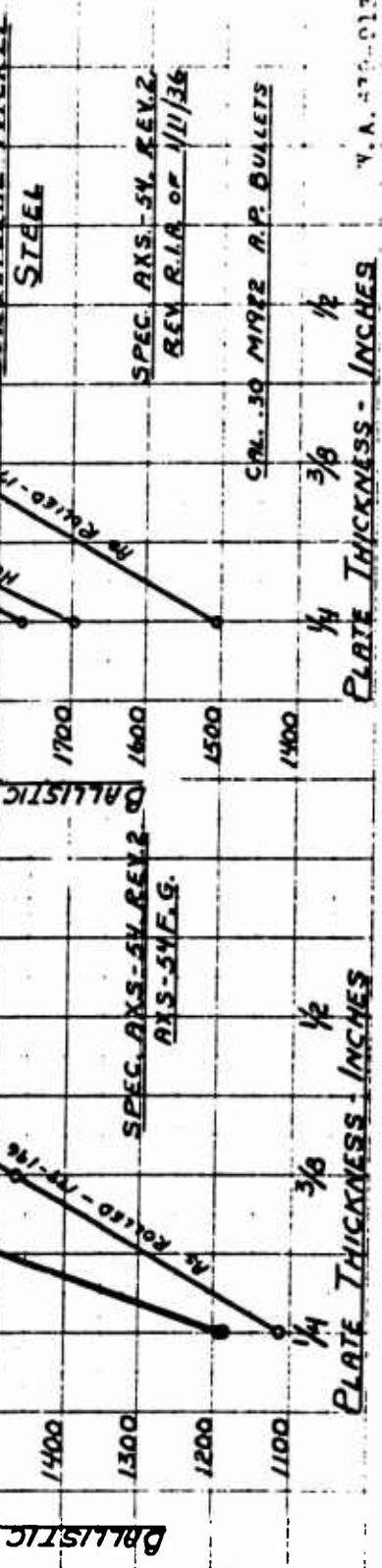
Summary of Ballistic Efficiency of Carburized Plate
for Various Manufacturers and Periods

<u>Manufacturer</u>	<u>% Pass</u>	<u>% Brittle</u>	<u>Years</u>	<u>Spec.</u>
Carnegie	44	33	'22 - '32	150
	43	58	'32 - '33	31
	42	58	'33 - '34	Rev. 1
Crucible	35	60	'22 - '32	150
Diebold	100	0	'36	Rev. F, H, K
Disston	12	88	'22 - '32	150
	50	18	'32 - '33	31
	27	7	'33 - '34	31
	100	0	'34 - '36	Rev. 2
	100	0	'36	Rev. F, H, K
Halcomb	80	4	'22 - '32	150

TABLE 4 (c)

Summary of Ballistic Efficiency of Nitrided Plate
for Various Manufacturers and Periods

<u>Manufacturer</u>	<u>% Pass</u>	<u>% Brittle</u>	<u>Years</u>	<u>Spec.</u>
Ludlum	67	0	'22 - '32	150
Eddystone	38	48	'32 - '33	31
Watertown Arsenal	77	4	'34 - '36	Rev. 2



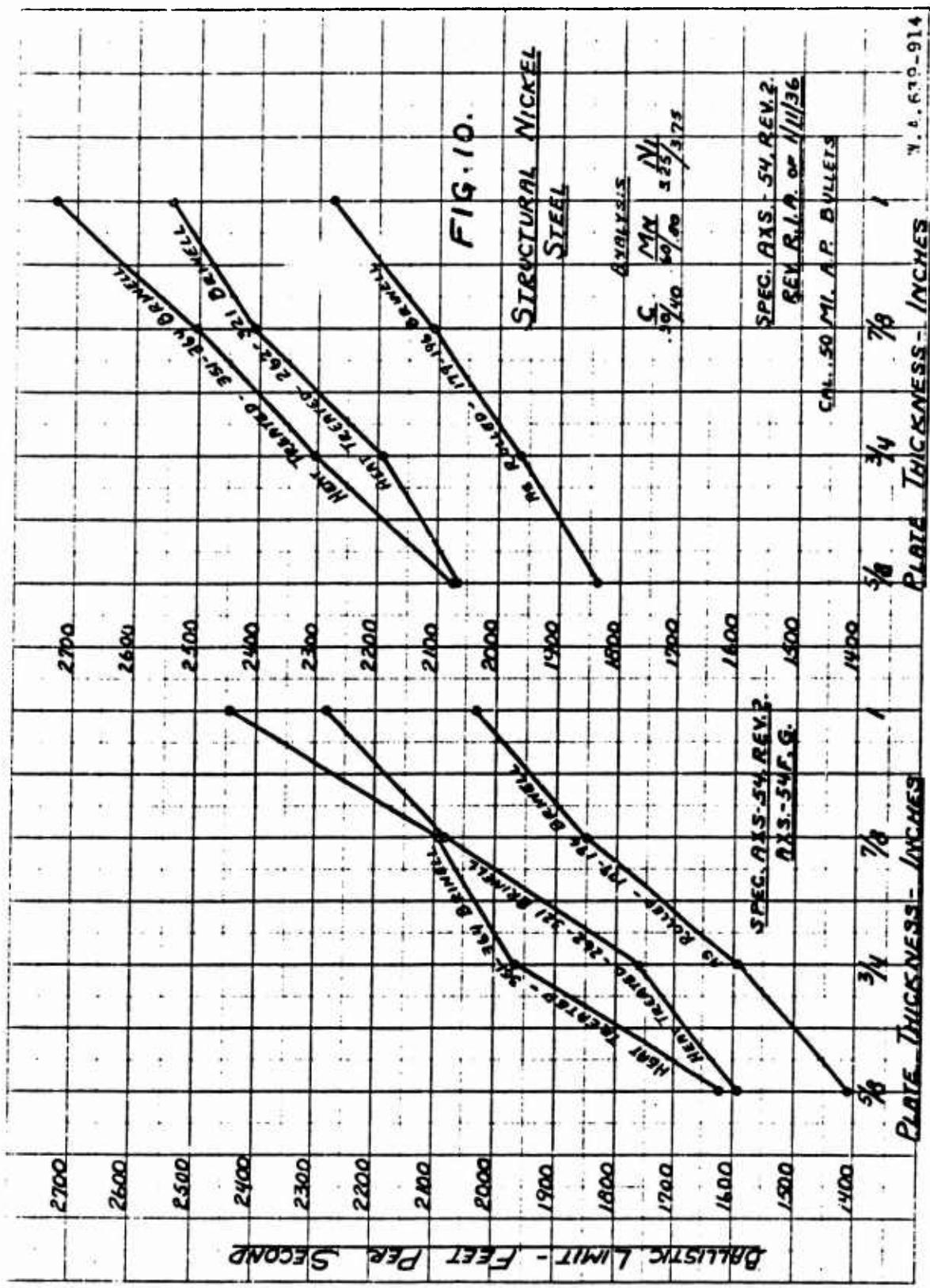


Fig 11a.
HOMOGENEOUS ARMOR PLATE

H. DIBSTON & SONS CO.

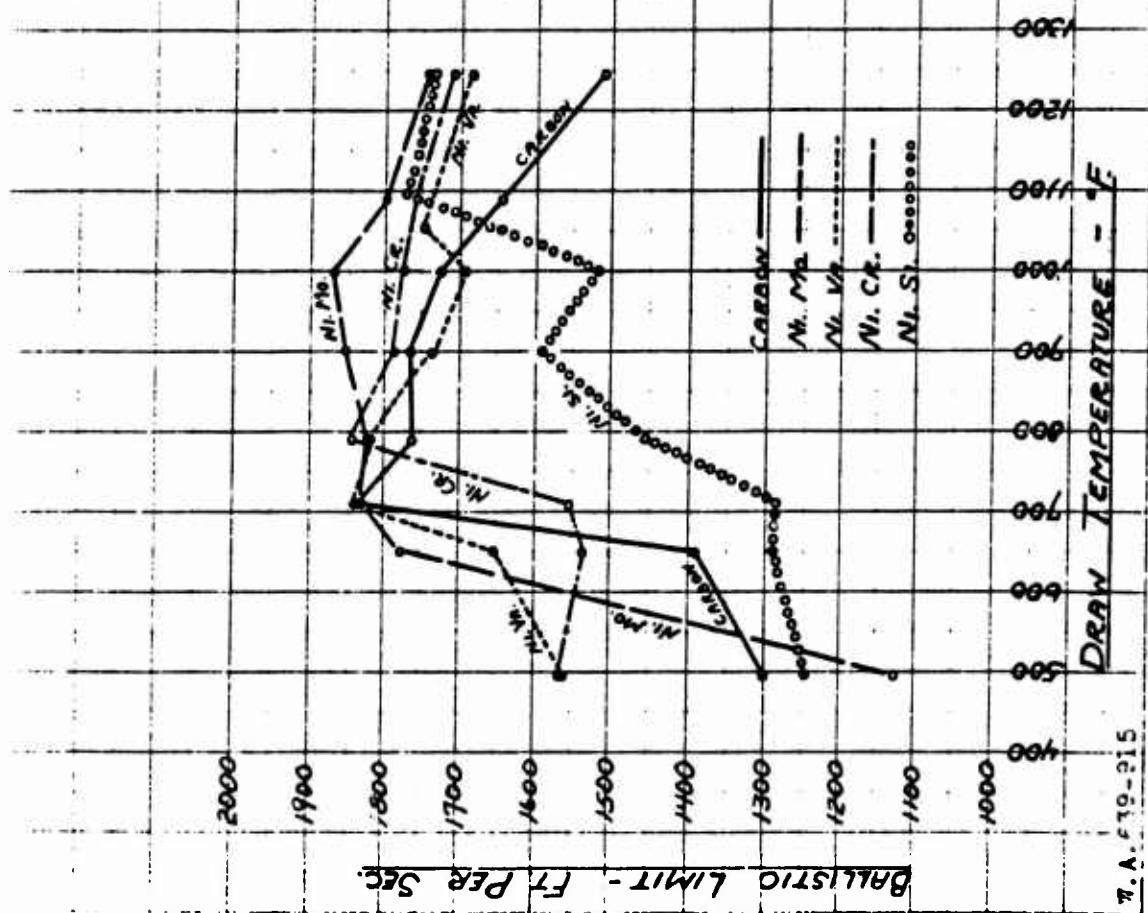
1/4 INCH THICKNESS

CHEMICAL COMPOSITION
AND
DRAW TEMPERATURE
VS.
BALLISTIC LIMIT

Type of Steel	Heated to	Quenched in
Carbon	1450° F.	H ₂ O
Ni. Mo.	1500° F.	Oil
Ni. Va.	1500° F.	Oil
Ni. Cr.	1500° F.	Oil
Ni. Si.	1475° F.	Oil

Data Taken From 18th PARTIAN REPORT.

Cal. 30 A.P. - 150 Gr. Bullets
73 Gr. Core.
150 Foot Range



7. A. 519-215

FIG. 11b.
HOMOGENEOUS ARMOR PLATE

H. DIXON AND SONS CO.

3/8 INCH THICKNESS

CHEMICAL COMPOSITION
AND

DRAW TEMPERATURE

V.S.
BALLISTIC LIMIT

TYPE OF STEEL	HEATED TO	QUENCHED IN
CARBON	1455°F.	H ₂ O
Ni. Mo.	1505°F.	O/L
Ni. V.	1505°F.	O/L
Ni. Cr.	1510°F.	O/L
Ni. Si.	1480°F.	O/L

DATA TAKEN FROM 12 IN PRACTICE REPORT

CAL. .30 A.P. - 150 GR. BULLETS
73 GR. CORE
150 FOOT RANGE

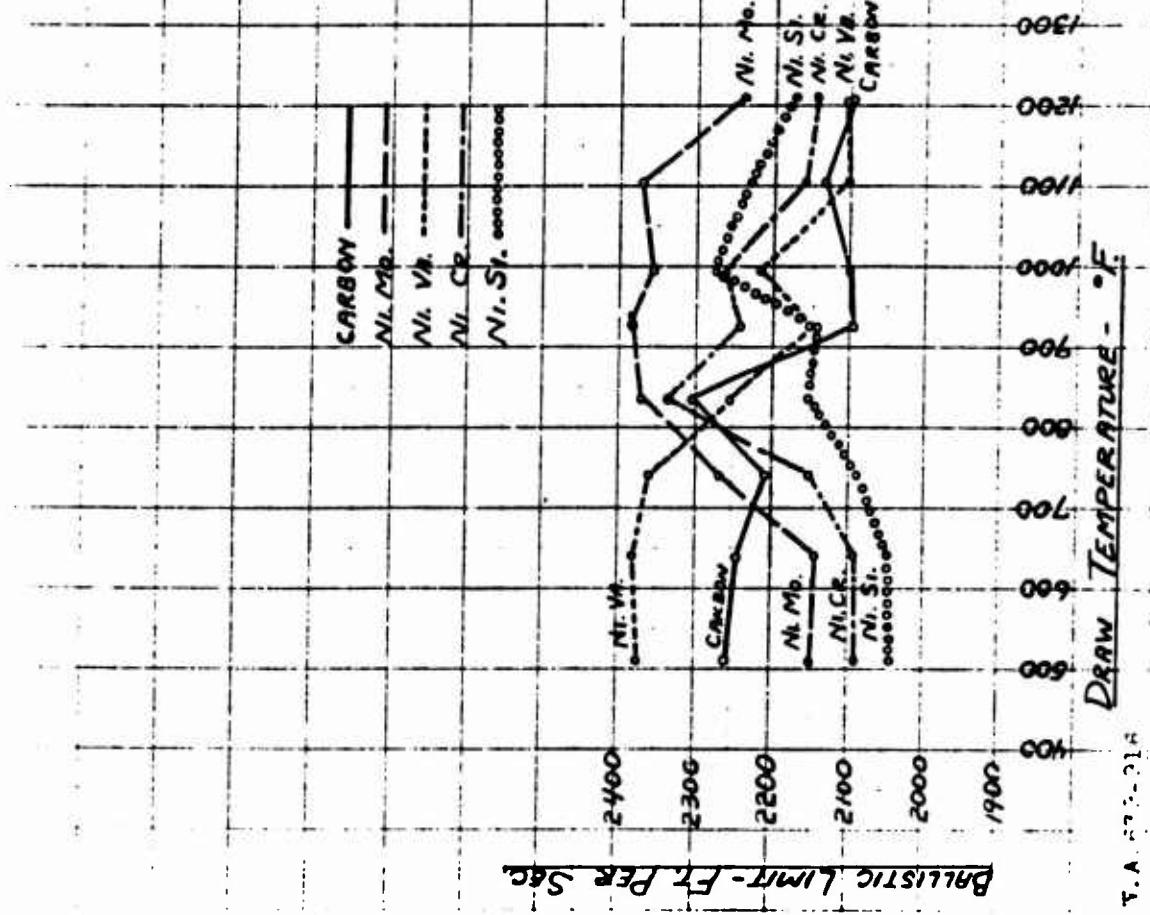


FIG. 11C.

HOMOGENEOUS ARMOR PLATE

H. DUGGON AND SONS CO.

1/2 INCH THICKNESS

CHEMICAL COMPOSITION

DRAW TEMPERATURE
VS.
BALLISTIC LIMIT

TYPE OF STEEL HEATED TO	QUENCH IN
CARBON	H ₂ O 95° F.
Ni. Mo.	1510 °F.
Ni. Va.	1515 °F.
Ni. Cr.	1505 °F.
Ni. Si.	1485 °F.

Data Taken from 12 in Prelim Report

CAL. 30 A.R. - 150 GR. BULLETS.
 73 GR CORR.
 150 FOOT RANGE

Watertown Arsenal experimental nitrided plate passed specifications 77%.

This information was based on Tables 4a, b, c.

The ballistic properties of rolled and heat treated structural nickel steel are given in Figs. 9 and 10.

Fig. 11 illustrates the ballistic properties of various compositions drawn at various temperatures.

Discussion

The results of this investigation are based entirely on the correlation of ballistic data taken from the Aberdeen reports. It is believed, however, that more reliable conclusions can be obtained if a correlative study of microstructure with ballistic properties is made, reference W.A. Report 710/242.

Due to difficulty in obtaining cooperation from armor plate manufacturers, in recent years very few test samples have been available for such study. On the basis of examinations made at this Arsenal, we are convinced that a definite correlation between microstructure and ballistic properties can be established. However, we have been hampered by the fact that all our investigations have necessarily been confined to samples which the manufacturers were willing to supply about ten years ago.

It is interesting to note that while carburized plate has been steadily improving over the years, the same improvement is not evident for homogeneous plate. We believe, however, that with sufficient cooperation between this Arsenal and the manufacturers, coupled with more complete investigation of heat treatment and micro-structure, a much superior homogeneous plate could be developed. In view of the fact of greater rapidity of manufacture during emergency, we believe this program to be feasible.

During the period 1922-1932, the face hardened plate, subjected to Cal. .30 ammunition, shows an advantage up to a thickness of $3/8"$, beyond which the homogeneous plate is superior. However, subjected to Cal. .50 ammunition, the face hardened plate shows itself superior up to a thickness of $3/4"$, whereupon the homogeneous plate regains its advantage (Figs. 6 and 7).

A study of the more recent performances shows that the trend seems to be for face hardened plate to continuously increase its advantage. Thus, during 1932-1933 (Figs. 4 and 5), we note that carburized plate subjected to Cal. .30 impact now retains its superiority up to a thickness of $9/16"$, while under Cal. .50 impact the results are very ambiguous.

While from 1933 to date (Figs. 2 and 3), the curves indicate that now under Cal. .30 shot, carburized plate is superior to homogeneous plate to a point beyond the thickness recommended for Cal. .30 ammunition test, i.e. .525". Under Cal. .50 impact, the face hardened plate exceeds the homogeneous plate up to 5/8" plate thickness, where the curves meet and continue to show identical results up to 7/8", beyond which thickness no acceptable homogeneous plate has been submitted by manufacturers.

The line for the proposed specification was drawn in approximately 100 foot-seconds less than and parallel to the curve of the average performance of the high quality carburized plate on the Cal. .30 graph. On the Cal. .50 graph, the proposed line was drawn about 50 foot-seconds below the line representing the carburized plate.

It was noted that the AXS-54 K-1 Specifications were too lenient in requirements for light plate - up to .5", beyond this thickness, however, they are too high. (See Fig. 1).

Fig. 8 represents ballistic limits of 37 M.I. impact on heavy plate. The curve is extrapolated to show what performance might be expected for even heavier plate than tested to date.

The ballistic values plotted in Fig. 8 represent

four face hardened plates and only one homogeneous plate. All these plates showed various degrees of buttoning and spalling.

In reviewing the behavior of other homogeneous plates, mentioned in the Aberdeen Reports, to 37 MM. attack, it was noted that heat treated homogeneous structural nickel steel (1/2" - 1" thick) shows evidence of brittleness when subjected to such an impact.

In Table 3 is demonstrated the possibility of testing light gage plate, 1/4 - 5/8" thick, with 37 MM. solid shot for a ductility test.

Such plate was shattered to a marked degree under high velocity impact.

On the basis of recent investigations at Watertown Arsenal, under Cal. .30 impact, the advantages of nitrided plate disappears in plate thicknesses in excess of 3/8".

Nitrided chrome-moly-vanadium steels have superior ballistic properties when compared with other steels containing aluminum, as shown by the de Marre Coefficients (Table 11c).

The variation in chemical composition does not appear to cause as marked a difference in ballistic limit as does the variation heat treatment in the cases studied. (See Figs. 11a, b, c).

Summary

1. The performance of various manufacturers' armor plate within the last five years are noted below:

A. Carburized

- | | | |
|----------------------------|------|------------|
| (1) Diebold (experimental) | 100% | pass spec. |
| (2) Disston | 75% | " " |
| (3) Carnegie | 42% | " " |

B. Homogeneous

- (1) Disston (only plate supplied) - 25% pass spec.

C. Nitrided

- (1) Watertown Arsenal (experimental) -
77% pass spec.

2. Heat treated structural nickel steel has good ballistic properties under Cal. .30 and Cal. .50 impact, but shows brittleness under machine gun fire and 37 MM. solid shot impact. Steel has good ballistic properties.

3. Within the last five years, the advantage of face hardened plate under Cal. .30 impact disappears in plate thickness of .525".

Under Cal. .50 impact, face hardened plate exceeds homogeneous plate up to 5/8" plate thickness, where the curves meet and continue to show identical results up to 7/8", beyond which thickness no acceptable homogeneous plate has been submitted by manufacturers.

The advantage of nitrided plate disappears in plate thickness of 3/8".

4. With the exception of the 37 MM. graph, all graphs were plotted from data obtained from good quality plate showing no evidence of brittleness. All heavy plate subjected to 37 MM. impact showed evidence of brittleness.

5. No conclusions could be drawn in regard to the relationship of ballistic limit and Brinell hardness values.

Investigations at Watertown Arsenal have shown that although high and low ballistic armor plate may occasionally have the same Brinell hardness, the cause of failure in the poor plate was due to nonuniformity of microstructure, such as presence of carbides at grain boundaries, ferrite segregations or laminations.

6. Research at Watertown Arsenal has shown that there is a definite relationship between microstructure and ballistic properties of armor plate. Correct heat treatment applied to plate, thus producing the correct structure, is of more importance in obtaining high ballistic properties than normal variation in chemical composition.

Acknowledgment

Mr. A. Hurlich classified all armor plate recorded in the Aberdeen Reports into homogeneous and face hardened plate, according to manufacturer, composition, and thickness, and plotted Figs. 9, 10, 11a, b, c.

Respectfully submitted,

E. L. Reed.

E. L. Reed,
Research Metallurgist.

S. L. Kruegel

S. L. Kruegel,
Jr. Science Aide.

TABLE 5 (c) - Tabulation of Data from Aberdeen Reports

HC OGETICUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cul.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>CRUCIBLE</u>	<u>1/4"</u>	.25	30	150	1784	444
Cr-Io					1642	444
					1594	402
C = .50					1633	402
Cr = .90					1600	364
Mo = .28					1639	351
					31	Slivers
					1664	370
				AXS-54 -1	1153	370
						Slivers plate dished
	<u>5/16"</u>	.313	30	150	1820	444
					1823	444
					1883	402
					1846	389
					1852	351
					1880	351
	<u>3/8"</u>	.375	30	150	2012	512
					1976	444
					2143	444
					2246	444
					2100	402

TABLE 5 (a) - Cont'd

HOMOGENEUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
CRUCIBLE	3/8" .375 (Cont'd)	30	150	2192	402	
				2260	402	
				2235	402	
				2118	351	
				2133	351	
				2277	351	
				2184	351	
				2137	444	
				1346	387	
		50	150	1389	351	
				120 ft. range	1934	512
						Buttons
	7/16" .438	30	150	2224	444	Buttons
				2025	512	Cracks
				2039	512	Buttons
	1/2" .500	30	150	2662	477	
				2670	444	
				2657	444	
				2452	402	
				2654	402	
				2548	364	
				2563	364	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>CRUCIBLE</u>	1/2" .500 (Cont'd)	50	150	1391	444	Buttons
	3/4" .75	50	150	2246	495	Cracked
				2273	495	"
				2225	444	Buttons
				2270	412	
				2261	364	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u>	.25	30	150	1748	418
Straight Carbon					1788	418
					1751	418
C = .495-.47					1783	387
Mn = .74-.63					1772	387
Si = .16					1790	418
					1781	418
					1691	477
					1628	387
						Cracked Slivers
	<u>5/16"</u>	.313	30	150	1921	321
					1926	332
	<u>3/8"</u>	.375	30	150	2113	302
					2106	302
					2165	364
					2164	351
					2196	364
					2119	255
					2243	351
					2303	351
	<u>7/16"</u>	.438	30	150	2293	332
					2296	332

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/2" .500</u>	<u>30</u>	<u>150</u>	<u>2553</u>	<u>324</u>	
				<u>2590</u>	<u>293</u>	
				<u>2506</u>	<u>321</u>	
				<u>2453</u>	<u>302</u>	
				<u>2412</u>	<u>302</u>	
				<u>2442</u>	<u>302</u>	
				<u>2529</u>	<u>448</u>	
				<u>2459</u>	<u>340</u>	
				<u>2406</u>	<u>418</u>	
		<u>50</u>	<u>150</u>	<u>1532</u>	<u>430</u>	<u>Buttons</u>

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u>	.25	30	150	1826	387
					1831	402
Ni-Cr					1821	402
					1839	387
C = .41-.40					1795	375
Ni=3.39-3.37					1851	387
Cr=1.35-1.30					1795	387
					1831	387
	<u>5/16"</u>	.313	30	150	2067	375
					2084	375
	<u>3/8"</u>	.375	30	150	2270	387
					2318	387
					2288	375
					2279	375
					2292	375
					2296	364
					2301	375
					2277	375
			<u>50</u>	<u>150</u>	<u>1216</u>	<u>375</u>
					1357	332

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>7/16"</u> .438	30	150	2499	430	
				2485	460	
	<u>1/2"</u> .500	30	150	2710	512	
				2845	532	
				2796	532	
				2845	512	
				2847	512	
				2845	512	
				2837	402	
				2831	512	
				2508	512	
				50	150	1588
						512

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u> .25	30	150	1830	387	
				1833	387	
Ni-Mo				1828	387	
				1638	387	
C = .485-.37				1835	387	
Ni=4.55-4.35				1831	387	
Mo=1.28-.36				1851	387	
				1842	387	
		50	150	1099	387	
	<u>5/16"</u> .313	30	150	2127	387	
				2134	418	
	<u>3/8"</u> .375	30	150	2315	375	
				2330	387	
				2325	387	
				2361	418	
				2337	387	
				2328	375	
				2339	387	
				2337	387	
	<u>7/16"</u> .438	30	150	2535	387	
				2550	387	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	1/2" .500	30	150	2535	327	
				2858	430	
				2674	367	
				2674	387	
				2724	418	
				2742	387	
				2719	375	
				2713	387	
				2739	387	
				2706	375	
		50	150	1538	387	
				1625	387	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>	
<u>DISSTON</u>	<u>1/4"</u>	.25	30	150	1756 1716	340 364	Brittle & cracked "
NI-SI					1734	364	"
					1756	364	"
C = .52-.38 Ni=3.09-2.97 Si=1.95-1.76					1728	364	"
					1542	387	"
					1714	364	"
					1710	364	"
	<u>5/16"</u>	.313	30	150	2071 2084	364 375	
	<u>3/8"</u>	.375	30	150	2325 2299 2253 2327 2322 2356 2362 2347	364 364 375 375 351 364 375 375	
			50	150	1394	387	
	<u>7/16"</u>	.438	30	150	2478 2498	418 402	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>CISSTON</u>	1/2"	.500	30	150	2793	444
					2732	387
					2752	364
					2868	375
					2778	375
					2819	430
					2759	375
					2837	430
				50	150	1649
						387

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u>	<u>.25</u>	<u>30</u>	<u>150</u>	<u>1761</u>	<u>340</u>
					<u>1804</u>	<u>387</u>
Ni-Va					<u>1800</u>	<u>302</u>
					<u>1829</u>	<u>387</u>
C = .36-.30 Ni=3.20-3.11 Va=1.04-.23					<u>1883</u>	<u>418</u>
					<u>1837</u>	<u>387</u>
					<u>1857</u>	<u>387</u>
					<u>1821</u>	<u>302</u>
	<u>5/16"</u>	<u>.313</u>	<u>30</u>	<u>150</u>	<u>2142</u>	<u>387</u>
					<u>2112</u>	<u>387</u>
	<u>3/8"</u>	<u>.375</u>	<u>30</u>	<u>150</u>	<u>2343</u>	<u>387</u>
					<u>2346</u>	<u>387</u>
					<u>2291</u>	<u>375</u>
					<u>2371</u>	<u>418</u>
					<u>2350</u>	<u>387</u>
					<u>2364</u>	<u>418</u>
					<u>2359</u>	<u>418</u>
					<u>2350</u>	<u>387</u>
					<u>2192</u>	<u>387</u>
	<u>7/16"</u>	<u>.438</u>	<u>30</u>	<u>150</u>	<u>2403</u>	<u>387</u>
					<u>2410</u>	<u>364</u>

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
DISSTON	1/2"	.500	30	150	2743	418
					2666	364
					2835	444
					2737	418
					2856	418
					2791	418
					2778	405
					2712	375
				50	150	1651
						302

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>3/8"</u> .375	30	150	1986	387	
Mn-Ni-Va		50	150	1322	387	
C = .35-.30						
Mn= 1.0				1309	444	
Ni=3.2-3.1						
Va=.25						
<u>DISSTON</u>	<u>3/8"</u> .375	50	150	1361	387	
Ni						
C = .40						
Ni= 4.60						
<u>DISSTON</u>	<u>3/8"</u> .375	50	150	1309	444	
Mn-Mi						
C = .36						
Mn= 1.02						
Ni= 3.17						
<u>DISSTON</u>	<u>3/8"</u> .375	50	150	1395	364	
Mn-Ni-Si						
C = .33-.43						
Mn=1.10-1.02	<u>1/2"</u> .500	50	150	1650	387	
Ni=3.09-3.04						
Si=1.63-2.05						
<u>DISSTON</u>	<u>1/2"</u> .500	50	150	1651	302	
Mn-Mo-Ni						
C = .39						
Mn= 1.02						
Mo= .23						
Ni= 3.24						

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/8"</u> .125	30	31	1003	402	Cracked
Cr-Mo-Va				1029	418	
				1048	364	
C = .55-.38 Cr=1.35-1.00 Mo=.86-.56 Van.3 - .2				986	387	
	<u>3/16"</u> .188	30	31	1522	418	
				1382	-	
				1486	418	
				1539	418	
				1531	418	
				1543	418	
				1498	418	
				1526	430	
				1560	444	
				1237	401	
				AXS-54 -1	895	-
					949	401
	<u>1/4"</u> .281	30	31	1841	418	
				1755	444	
				1758	401	
				1698	418	
				1543	-	
				1631	410	Slivers

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u> .281 (Cont'd)	30	31 (Cont.)	1545	424	Buttons
Cr-No-Va				1874	418	
				1815	418	
				1716	418	
				1827	418	
				1656	418	Slivers
				1748	364	
				1809	395	
				1889	387	
				1772	403	
				1738	410	
				1640	439	
				1841	431	
				1715	431	
				1861	418	
				1710	418	
				1787	387	
		AXS-54 -1	1293	418	Slivers	
			1228	364		
			1262	395		
			1258	387		
			1340	403		
			1279	410		

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/4"</u> .25 (Cont'd)	30	AXS-54 -1 (Cont.)	1456	449	
<u>Cr-Mo-Va</u>				1324	431	
				1441	431	
				1195	403	
				1183	403	
				1215	401	
			AXS-54 -2	1247	420	Slivers
				1229	424	Spall
	<u>5/16"</u> .313	30	31	2128	418	
	<u>3/8"</u> .375	30	31	2304	418	
				2173	418	
				2229	418	
				2128	444	
				2224	418	
				2239	431	
				2227	418	
				2209	418	
				2304	431	
				2276	431	
				2200	382	
				2264	426	
				2311	430	
				2117	430	

TABLE 5 (a) - Cont'd

HOMOGENECUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>.357</u>	<u>30</u>	<u>31</u>	<u>2297</u>	<u>430</u>	
	(Cont'd)		(Cont.)	2095	461	Buttons
Cr-Mo-Va				2234	437	Spalled
				2178	424	"
				2192	387	
				2270	-	
				2128	444	
				2234	437	
				2178	424	
<hr/>						
			<u>AXS-54</u>	<u>1738</u>	<u>382</u>	
			-1	1811	403	
				1762	418	
				1800	461	Buttons
<hr/>						
			<u>AXS-54</u>	<u>1877</u>	<u>437</u>	<u>Spalled</u>
			-2	1854	424	"
<hr/>						
	<u>.438</u>	<u>30</u>	<u>31</u>	<u>2545</u>	<u>418</u>	
				2576	418	

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/2"</u> .500	30	150	2603	418	
Cr-No-Va				2630	418	
C = .53-.58				31	2596	352
Cr=1.21-1.12					2527	370
Mo=.86-.56					2643	387
Va=.30-.25					2687	395
					2700	410
					2651	499
					2739	418
					2726	444
					2744	418
					2561	387
					2519	364
					2594	395
					2468	431
					2685	437
					2678	444
					2654	444
					2703	418
					2707	430
					2606	364
					2721	444

TABLE 5 (a) - Cont'd

HOMOGENEUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
D-SSTCN	1/2" .500 (Cont'd)	30	AXS-54 -1	2470	430	Spall
Cr-Mo-Va				2242	364	
				2159	352	
				2221	370	
				2345	387	
				2390	395	
				2380	410	
				2366	499	
				2518	418	
				2431	444	
				2242	395	
				2296	410	
				2304	410	
				2326	450	
			AXS-54 -2	2451	437	Spalled
				2445	444	"
				2720	444	
				2718	444	
			AXS-54 -H	2497		Experimen- tal
			AXS-54 -K	2609		Experimen- tal

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>1/2"</u> .500 (Cont'd)	50	150	1725	500	Cracks
Cr-Mo-Va				1860	418	
				1823	418	
		31		1956	418	
				1812	418	
				1932	418	
				AXS-54	1826	470
				-1		

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
DISSTON	5/8" .625	50	150	1895	477	Buttons
Cr-Mo-Va				1795	512	Spalled
				1826	512	Spalled
C = .51-.5				1742	512	Spalled
Cr = 1.12-1.05				1807	418	
Ni = .76-.65				1862	418	
Va = .25				1419	500	Cracked
		50	31	2325	430	
				AXS-54 -H	1723	Exp. Buttons
					1763	
				AXS-54 -K	2122	Exp.
					2117	

TABLE 5 (c) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>DISSTON</u>	<u>3/4"</u>	.75	50	31	2245	358 Cracked
Cr-No-Va					2539	437
C = .5-.29 Cr = 1.36-1.12 Mo = .71-.65 V = .25				AXS-54 -1	1873	358 Cracked
				-K	2361	Exp.
					2351	"
	<u>7/8"</u>	.875	50	AXS-54 -R	2500	Exp.
	1"	1.00	50	31	2568	418
					2769	358
				AXS-54 -1	2445	358

TABLE 5 (a) - Cont'd

HOMOGENEOUS

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>EDDYSTONE</u>	3/16"	.188	30	31	1568	387
Cr-La-Va	1/4"	.25	30	31	1793	430 Slivers
C = .50					1769	418 Buttons
Cr = 1.10					1797	418
Mo = .60					1818	418
Va = .25					1821	418
	3/8"	.375	30	31	2368	418
					2283	418 Slivers
					2285	418 "
					2296	444
					2325	444
					2296	444
					2346	444 Slivers
					2245	444 Spalled
					2264	444 "
	1/2"	.500	30	31	2752	418
<u>EDDYSTONE</u>	3/16"	.188	30	150	1450	387
Cr-Va					1457	387
C = 0.45						
Cr = 1.10	1/2"	.500	50	150	1556	387 Buttons
Va = 0.25						

TABLE 5 (b) - Tabulation of Data from Aberdeen Reports

<u>Manufacturer</u>	<u>Thickness</u>	<u>CAREURIZED</u>				<u>Brinell</u>	<u>Front</u>	<u>Back</u>	<u>Remarks</u>
		<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>					
CARNEGIE	1/4"	.25	30	31	2036	555	555		
					2044	555	555		
					1964	512	512	Spalled	
					AXS-54 -1	2027	555	555	
	3/8"	.375	30	150	2481	600	444		
				31	2188	555	555	Buttons	
					2170	555	555	"	
					AXS-54 -1	2174	555	555	Buttons
	1/2"	.500	50	150	1572	652	477	Buttons	
				150	2200	600	512	Buttons	
				31	2158	555	555	Spalled	
					2146	555	532	"	
					AXS-54 -1	2158	555	555	Spalled
						2146	555	532	"

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>				
					<u>Front</u>	<u>Back</u>					
<u>CARNEGIE</u>	3/4"	.75	50	31	2119	555	555	Spalled			
					2109	532	532	"			
					2188	512	512	"			
				AXS-54 -1	1981	555	555	Spalled			
					2109	532	532	"			
					2057	512	512	"			
				7/8"	.875	600	280	Spalled			
					2589	600	280	"			
				1"	1.00	50	150	2489			
						600	280				
					2501	-	-				
					2494	-	-				
				31	2854	532	532				
					2839	532	477				
				AXS-54 -1	2854	532	532				
					2661	532	477				

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>
					<u>Front</u>	<u>Back</u>	
<u>CRUCIBLE</u>	<u>3/8"</u> .375	30	150	2330	555	555	Buttons
Cr-Mo-Ni-Si				2449	555	555	"
				2333	600	600	"
		50	150	2089	600	600	Cracked
Cr-Mo-Ni-Si- Va-W	5/8" .375	30	150	2211	555	555	
Co-Cr-Mo-Si- Va-W	5/8" .375	30	150	2155	600	600	Buttons
				2040	555	555	"
		50	150	2318	555	555	Shat- tered
Cr-Co	3/4" .75	50	150	2360	447	-	
C = .50				2137	512	269	
Cr = .90				2216	418	-	
Mo = .28				2191	418	-	
				2104	555	-	
				2116	460	286	
				2306	683	269	
				2298	652	286	
				2115	418	255	
				2141	512	269	
				2201	512	293	
				2133	495	262	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cel.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>
					<u>Front</u>	<u>Back</u>	
CRUCIBLE Cr-Mo	3/4" .75 (Cont'd)	50	150 (Cont.)	2258	713	255	
				2042	418	362	
				2241	683	293	
				2247	600	311	
				2340	532	286	
				2388	652	277	
				2120	495	277	
				2293	627	277	
				2264	578	248	
				2221	430	293	

TABLE 5 (b) - Cont'd

CASED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Remarks</u>
DIEFOLD	1/4"	.25	30 AXS-54 -F	1947	Experimental
				2027	"
				2092	"
	5/16"	.313	30 AXS-54 -F	2085	Experimental
	3/8"	.375	30 AXS-54 -F	2320	Experimental
				2212	
	7/16"	.438	30 AXS-54 -F	2249	Punch began
				2556	Experimental
				2528	"
				2490	"
	1/2"	.500	30 AXS-54 -F	2693	Experimental
	9/16"	.563	30 AXS-54 -F	2687	Experimental
				2713	
	5/8"	.625	50 AXS-54 -F	2154	Experimental
				2142	"
	3/4"	.75	50 AXS-54 -F	2310	Experimental

TABLE 5 (b) - Cont'd

CARBONIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Remarks</u>
<u>DIEBOLD</u>	1"	1.00	50	AXS-54 -F	2609 Experimental
	1 1/8"	1.13	50	AXS-54 -F	2708 Experimental
	1 1/4"	1.05	50	AXS-54 -F	Partial Experimental at 2897+

TABLE 3 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>
					<u>Front</u>	<u>Back</u>	
DISSTON	1/8" .125	30	31	1006	321	340	
				1022	340	340	
Cr-Mo-Va				1123	387	340	
				1240	461	410	
C = .26-.23				1262	512	403	Slivers
Cr=1.36-1.00				1443	403	387	Spall
Mo = .03-.58				1113	555	444	"
Va = .30-.20				1087	555	447	
				1120	403	364	
				1095	444	418	Button
				1111	444	418	
				1162	387	387	
				1046	387	387	
				1273	418	418	
				1125	418	364	Crack
	3/16" .188	30	AXS-54 -H	1921	-	-	Experimental
	1/4	.25	30	31	2034	486	402
					1789	469	387
					1905	444	354
					1920	477	364
					1916	444	351
					1792	430	340

TABLE 5 (b) - Cont'd

CASEURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>
					<u>Front</u>	<u>Back</u>	
DISSTOR	1/4" .65 (Cont'd)	30	31 (Cont.)	2024	512	431	
Cr-Io-Vs				2177	534	418	
				2227	555	432	
				2084	512	418	
				2906	512	403	
				1990	495	403	
				2100	600	544	Cracked
				1836	486	437	
				2290	600	477	Cracked
				2162	600	444	
				1645	444	302	
				1576	444	364	
				1729	477	418	
				1661	477	418	
				1686	495	413	Slivers
				1586	512	403	
				1698	477	403	
				1714	477	403	Slivers
				1697	477	418	
				1625	486	418	
				1642	488	418	Slivers
				1699	477	418	
				1485	343	212	
				1468	343	248	

TABLE 5 (b) - Cont'd

CASEHARDENED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Front</u>	<u>Back</u>	<u>Remarks</u>
<u>DISSTOR</u>	<u>1/4"</u>	<u>.25</u>	<u>30</u>	<u>51</u>	<u>1472</u>	<u>311</u>	<u>129</u>	
			(Cont'd)	(Cont.)				
Cr-Mo-Va					1400	504	418	
				AXS-54 -1	2034	466	402	
					1789	469	387	
					1905	444	354	
					1920	477	364	
					1916	444	351	
					1792	430	340	
					1645	444	302	
					1576	444	364	
					1729	477	418	
					1625	477	418	
					1686	495	418	Slivers
					1586	512	403	
					1698	477	403	
					1708	477	403	Slivers
					1697	477	418	
					1572	486	418	
					1586	488	418	Slivers
					1699	477	418	
					1C28	343	212	
					1138	343	248	
					1059	311	129	
					1255	504	418	

TABLE 5 (b) - Cont'd

CARBURIZED

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Front</u>	<u>Back</u>	<u>Remarks</u>
DISSTON Cr-No-Ve	3/8" .375 (Cont'd)	30	31 (Cont.)	2256 2205 2130 2543	477 512 477 534	431 444 418 410		Slivers
			AXS-54 -1	2253 2123 2004 1954 1847 1794 1836 1858 1851 1817 1900 2543	495 495 312 444 430 495 486 477 477 512 477 477	364 340 340 302 364 403 431 410 431 444 418 418		
			AXS-54 -H	2471				Experimental
		50	31	1766 1920 1833 1863	614 555 555 495	495 361 444 369	Crack "	
								Large hole Crack

TABLE 5 (b) - Cont'd

<u>Manufacturer</u>	<u>Thickness</u>	<u>Crl.</u>	<u>Spec.</u>	<u>Limit</u>	<u>CAREWIZED</u>		<u>Brinell</u> <u>Front</u>	<u>Back</u>	<u>Remarks</u>
					<u>Front</u>	<u>Back</u>			
DISSTON	1/2"	.500	30	150	2655	512	477		Buttons
Cr-Mo-V8					2622	555	512	"	
					2714	600	512	"	
					2641	578	555	"	
					2638	555	555	"	
					2628	512	477	"	
					3090	555	512	"	
					2650	555	477		
				31	2788	444	418		
					2603				
					2330				
					2669	492	321		
					2625	495	321		
					2653	387	340		
					2649	512	364		
					2897	566	330		
					2738	543	397		
					2714	533	350		
					2929	589	298	Buttons	
					3007	532	398		
					2947	600	341		
					3175	614	461	Spall	
					3008	600	402	"	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Col.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>	
					<u>Front</u>	<u>Back</u>		
<u>DISSTON</u>	<u>1/2"</u>	.500	30	31 (Cont.)	2817	469	461	Spall
Cr-Mo-V3					3152	600	431	"
					2821	600	418	
					3076	555	418	
					2581	418	269	
					2643	418	387	
					2161	476	295	
					2205	495	172	
					2756	554	395	
					2779	495	387	
					2831	512	418	
				<u>AXS-54</u>	<u>2675</u>	<u>444</u>	<u>418</u>	
				-1	2744	460	418	
					2353	492	321	
					2366	495	321	
					2472	387	340	
					2440	512	364	
					2273	418	269	
					2323	418	387	
					2434	554	395	
					1846	478	295	
					1899	495	172	
				<u>AXS-54</u>	<u>2683</u>			
				-2				

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>		<u>Remarks</u>
					<u>Front</u>	<u>Back</u>	
<u>DISSTON</u>	1/2"	.500	50	150	2187	600	512 Buttons
Cr-Mo-Va		(Cont'd)			2260	555	555 Cracks
					1592	555	512 Buttons
					2136	555	417 "
					31	1860	- -
						1823	- -
						2251	600 431 Buttons
						1920	512 302 Slivers
						2140	512 286
						1704	418 418 Buttons
						2195	512 418 "
						2283	555 364
						1894	460 418
						2291	600 402 Spall
						2122	566 330
						2115	544 397
						1891	495 387
					AXS-54	1826	460 418
					-1	2056	
	1"	1.00	50	AXS-54	2669		Experi-
				-H	2465		mental
	1 1/4"	1.25	50	AXS-54	2941		"
				-2			

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
HALCOMB	1/4"	.25	30	150	1887	430
Ni-Cr				1598	430	
				1745	400	
C = .14				1856	440	
Ni = 4.15				1868	444	
Cr = 1.43				1874	444	
				1572	430	
				1544	430	
				1830	460	
				1763	444	
				1869	444	
				1817	460	
				1871	460	
				1822	460	
				1876	460	
				1944	444	
				1897	477	
				1724	477	
				1892	555	
				1955	555	
				1925	555	
				1931	555	
				2003	555	
				2064	555	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>HALCOLB</u>	<u>1/4"</u>	<u>.25</u>	<u>30</u>	<u>150</u>	<u>2243</u>	<u>590</u>
		(Cont'd)		(Cont.)	2177	590
Ni-Cr				2235	590	
				2203	590	
	<u>5/16"</u>	<u>.313</u>	<u>30</u>	<u>150</u>	<u>2147</u>	<u>590</u>
				2224	"	
				2229	"	
				2254	"	
				2238	"	
				2204	"	
				2211	"	
				2196	"	
				2226	"	
				2240	"	
				2188	"	
				2193	"	
				2210	"	
				2234	"	
				2181	"	
				2191	"	
				2179	"	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>HALCOLB</u>	<u>3/8"</u> .375	30	150	2054	444	
Ni-Cr				1968	444	
				2015	460	
				2008	445	
				1970	360	
				2032	460	
				2240	512	
				2250	512	
				1931	477	
				2112	512	
				2146	578	
				2164	578	
				2276	578	
				2266	555	
				2333	600	
				2260	578	
				2007	477	
				2097	477	
				2181	522	
				2445	555	
				2188	555	
				2321	555	
				2320	578	
				2290	578	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
HALCOLB	3/8" .375 (Cont'd)	30	150 (Cont.)	2302	590	
Ni-Cr				2311	590	
				2335	590	
				2353	590	
				2310	590	
	7/16" .438	30	150	2367	590	
				2379	"	
				2333	"	
				2323	"	
				2343	"	
				2344	"	
				2328	"	
				2384	"	
				2334	"	
				2388	"	
				2330	"	
				2315	"	
				2348	"	Buttons
	1/2" .500	30	150	2572	590	
				2606	"	
				2531	"	
				2496	"	
				2531	"	

TABLE 5 (b) - Cont'd

CARTRIDGES

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
HALCOOLB	1/8" .500 (Counted)	50	150 (T.L.t.)	500	500	
W-Cr				2636	"	Buttons
				2570	"	
				2545	"	
				2597	"	
				2521	"	
				2580	"	
		50	150	1375	590	
				2023	"	
				2067	"	Cracked
				2043	"	
				2008	"	
				2023	"	
				2067	"	Cracked
				2080	"	
				2041	"	
				1996	"	
				2024	"	
				2037	"	
	3/4" .75	50	150	2148	444	
				2109	444	
				2070	444	
				2035	460	
				2108	460	

TABLE 5 (U) - Cont'd

CARBON STEEL

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
HALCO B Ni-Cr	3/4" .75 (Cont'd)	50	150 (Cont.)	2104	444	
				2076	444	
				2042	444	
				2115	495	
				2147	477	
				2242	532	
				2156	532	
				2318	555	
				2222	555	
				2193	555	
				2260	578	
				2167	444	
				2119	444	
				2374	600	
				2248	600	
				2303	600	
				2317	600	
				2353	600	
				2210	600	
				2253	590	Slivers
				2195	"	
				2243	"	
				2243	"	
				2214	"	

TABLE 5 (b) - Cont'd

CARBURIZED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
HALCOF	5/4"	.75	50	150 (Cont.)	2076	590
NI-Cr				2232	"	
				2284	"	
				2273	"	
				2211	"	Slivers
				2105	"	
				2149	555	

TABLE 3 (c) - Tabulation of Data from Aberdeen Reports

<u>NITRIDED</u>						
<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>EDDYSTONE</u>	<u>1/8"</u> .125	30	31	1296*	418	
				1362*	477	
<u>Cr-Vs</u>				1236*	477	
<u>C = .6</u>						
<u>Cr = 1.20</u>	<u>3/16"</u> .182	30	31	1824*	477	
<u>Va = .28</u>				1856*	477	
				1571	477	
				1531	461	Cracked
				1457	444	"
				1518	461	"
	<u>1/4"</u> .25	30	31	1905	444	
				2014	461	
				2014	495	
				1964	444	
				2053*	477	
				2148*	477	
	<u>3/8"</u> .375	30	31	2296*	477	
				2432*	477	
				2454	444	Cracked

* No Composition

TABLE 5 (c) - Cont'd

NITRIDED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Remarks</u>
<u>EDDYSTONE</u>	<u>1/2"</u> .500	50	31	2699*	477	
Cr-Va				2605*	477	
				2499	444	
				2470	444	
		50	31	1783	444	
				1782	444	
				2144*	477	Broke plate
	<u>5/8"</u> .625	50	31	2357*	444	Spalled
				2357*	444	"
	<u>3/4"</u> .75	50	31	2631	477	Spalled
<u>*No composition.</u>				2437	444	"
	<u>1"</u> 1.00	50	31	2651	444	Plate broke
				2696	466	"

TABLE 5 (c) - Cont'd

UTTRIDED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>b. t. all</u>	<u>Remarks</u>
					<u>Front</u>	<u>Back</u>
LUDLUM	1/4"	.25	30	150	1852 477	367
Cr-Mo-Al				2000	444	387
				1807	477	228
C = .36						
Cr = 1.49	7/16"	.438	30	150	2370 477	280
Mo = .18						
Al = 1.23					2448 444	387
					2476 444	286

TABLE 5 (c) - Cont'd

NITRIDED

<u>Manufacturer</u>	<u>Thickness</u>	<u>Cal.</u>	<u>Spec.</u>	<u>Limit</u>	<u>Brinell</u>	<u>Front</u>	<u>Back</u>	<u>Remarks</u>
WATERTOWN ARSENAL EXPERIMENTAL	1/4"	.25	30 AXS-54 -2	2150 2050	1950 1850 2150 2050	-	-	Shat- tered
	3/8"	.375	30 AXS-54 -2	1975 1850				
	7/16"	.438	30 AXS-54 -2	2275				
	1/2"	.500	30 AXS-54 -2	2350 2550 2150 2275				

TABLE 6 (a)
HOMOGENEOUS - Spec. 150; Calibre .30

Thickness	Manufacturer	Chemical Composition	Arithmetical Means			Ballistic Averages			Specification			% of Plates			% of Brittle Plates		
			Brinell Limits	Brinell Mean	Brinell Limits	Brinell Mean	Brinell Limits	Brinell Mean	Brinell Limits	Brinell Mean	Brinell Limits	Passing Spec.	None	0	100	0	100
3/16" - 1/8" Endstone	Cr-Va	1/4" - .25" Crucible	Cr-Al	1649	1654	1731	1763	176	1774-14	179	1820-20	358	50	0	67	22	0
												357	91	100	0	0	0
5/16" - 3/13 Crucible	Cr-Al	5/16" - .25" Crucible	Cr-Al	1649	1654	1731	1763	176	1774-28	364	1824-28	364	91	100	0	33	0
												367	91	100	0	0	0
5/16" - 3/13 Crucible	Cr-Al	5/16" - .25" Crucible	Cr-Al	1649	1654	1731	1763	176	1774-32	373	1824-32	373	111	0	0	67	100
												377	91	100	0	0	0
Hasten	Straight C	1737	174	1707	1704	1731	1731	176	1774-36	387	1836-36	389	200	100	0	0	0
"	H1-Cr	1821	1821	1707	1704	1731	1731	176	1774-41	394	1821-41	394	2076-40	111	100	0	0
"	H1-Mo	1836	1836	1707	1704	1731	1731	176	1774-46	397	1836-46	397	2131-4	103	250	100	0
"	H1-Si	1951	1951	1707	1704	1731	1731	176	1774-51	403	1951	403	2078-47	111	100	0	0
Daston	Straight C	1851	1851	1707	1704	1731	1731	176	1774-56	409	1924-53	409	2078-47	143	100	0	0
"	H1-Va	2127	2127	1707	1704	1731	1731	176	1774-61	416	1924-61	416	2127-15	397	67	100	0

TABLE 6 (a) Cont'd

HOLLOWEENOUS - Spec. .150; Calibre .30

Thickness	Manufacturer	Composition	Chemical			Arithmetic Means			Optimum Averages			Specification			% of Plates Passing Spec.			% of Brittle Plate		
			Ballistic Limits		Brinell	Ballistic Limits		Brinell	Ballistic Limits		Brinell	Weight		53	64	29				
			3/8"	.375	Crucible	W-Mo	2133	406	2184	395	2182+53	384	50	100	0	0	0	0		
Maston	Straight C	2176	330				2176+53		330		50	100	0	0	0	0	0	0		
"	W-Cr	2290	377				2290+12		377		200	100	0	0	0	0	0	0		
"	W-Mo	2334	388				2334+10		388		250	100	0	0	0	0	0	0		
"	W-Si	2324	368				2324+24		368		111	100	0	0	0	0	0	0		
"	W-Va	2330	396				2347+15		397		167	100	0	0	0	0	0	0		
"	W-H-Va	1926	387				-		-		0	0	0	0	0	0	0	0		
7/16" .438 Crucible							2096	489			-	-	0	0	0	0	0	100		
DI on	Straight C	2225	332				2225+2		332		500	0	0	0	0	0	0	0		
"	W-Cr	2492	445				2492+7		445		143	100	0	0	0	0	0	0		
"	W-Mo	2543	387				2543+8		387		125	100	0	0	0	0	0	0		
"	W-Si	2488	410				2488+10		410		100	100	0	0	0	0	0	0		
"	W-Va	2407	376				2407+4		376		250	100	0	0	0	0	0	0		

TABLE 6 (a) Cont'd

HOLLOWCROSS - Spec. 150; Calibre .30

	Thickness	Manufacturer	Composition	Optimum Averages				Specification				# of Plates Passing Spec.	% of Brittle Plate
				Crucible	Ballistic Limits	Brinell's Limits	Brinell's Averages	Limits	Brinell's Limits	Brinell's Averages	Limits		
1/20 .500	Crucible	-	2601	414	2626	416	2626+47	416	48	100	0	0	0
	Digestion	Straight C	2433	339	2435	502	2435+512	502	200	100	0	0	0
"	NI-Cr	2785	504	2835	392	2728	393	2728+35	393	83	100	0	0
"	NI-Mo	2792	398	2793	397	2793+37	398	71	100	0	0	0	0
"	NI-Va	2765	406	2765	408	2765+50	408	53	100	0	0	0	0
"	Cr-Mo-Va	2617	418	2617	418	2617+24	418	71	100	0	0	0	0

TABLE 6 (a) Cont'd

HOMOGENEOUS - Spec. 150; Calibre .50

Thickness 3/8"	Crucible 375	Dissston	Chemical Composition Mn-Ni-Va	Arithmetical Means			Optimum Averages			Specification		
				Ballistic Limits	Brinells Limits	Brinells	Ballistic Limits	Brinells Limits	Brinells	Weight	140	Plates Passing Spec.
1/2"	500	Crucible	-	1391	416	414	-	-	-	-	1	100
	Dissston	Strelight C	1532	430	-	-	-	-	-	-	1	100
	"	Bl-Cr	1588	512	-	-	-	-	-	-	1	0
	"	Bl-Mo	1582	387	1588	512	1582	512	387	387	23	0
	"	Bl-Si	1619	387	1649	387	1649	387	1	1	0	0
	"	Mn-Va	1651	302	1651	302	1651	302	302	302	1	0
	"	Mn-Mo-Ni	1650	387	1650	387	1650	387	1	1	0	0
	"	Cr-Mo-Va	1803	445	1842	419	1842	418	418	418	53	33
	Eddystone	Cr-Va	1556	387	-	-	-	-	-	-	1	100
5/8"	625	Dissston	Cr-Mo-Va	1764	478	1821	475	1825-28	418	77	14	71
3/4"	75	Crucible	-	2255	442	-	2266-5	388	200	40	60	

No spec. for this thickness.
No spec. for this thickness.

TABLE 6 (a) Cont'd

TABLE 6 (a) Cont'd

HOMOGENEOUS - Spec. 31; Calibre .50

Thickness	Manufacturer	Chemical Composition	Arithmetic Means			Optimum Averages			Specification			% of Plates Passing Spec.	% of Brittle Plate
			Ballistic Limits		Brinell	Ballistic Limits		Brinell	Ballistic Limits		Brinell		
			Min.	Max.		Min.	Max.		Min.	Max.			
.52"	Disston	Cr-Mo-Va	1900	418		1900+59	418		1900	418	24	No Spec.	0
.625"	Disston	Cr-Mo-Va	2325	430		2325	430		1	100	0		
.75"	Disston	Cr-Mo-Va	2392	398		2539	437		1	50	50		
1"	1.00	Disston	2669	388		2669+100	338		10	100	0		

TABLE 5 (a) Cont'd

Thickness	Manufacturer	Chemical Composition	Arithmetic Means			Optimum Averages			Specifications			Passing Seconds.	Screens of Plate	Brittle Plates
			Ballistic Limits	Brinell's Limits	Ballistic Brinell's	Ballistic Limits	Brinell's Limits	Ballistic Brinell's	Weight	Weight	Weight			
CALIBRE .10														
3/16" .138	Disston	Cr-Mo-Va	922	401		22427	401	37	0	0	0			
1/4" .25	Crucible	Cr-Mo	1153	370		-	-	1	0	100				
	Disston	Cr-Mo-Va	1290	408	1310	410	1311+65	403	45	0	6			
3/8" .375	Disston	Cr-Mo-Va	1775	416		1770+27	401	59	0	25				
1/2" .500	Disston	Cr-Mo-Va	2335	410	2333	425	2372+51	425	56	7	7			
1/2" .500	Disston	Cr-Mo-Va	1826	470		1826	470	1	No Spec.	100				
3/4" .75	Disston	Cr-Mo-Va	1873	358		-	-	1	-	-	-			
1" 1.00	Disston	Cr-Mo-Va	2445	358		-	-	1	0	100				
HOLLOWEYED - Spec. Axs-54-2; Calibre .30														
1/4" .25	Disston	Cr-Mo-Va	1275	422		-	-	0	0	100				
3/8" .375	Disston	Cr-Mo-Va	1866	431		-	-	0	0	100				
1/2" .500	Disston	Cr-Mo-Va	2584	443	2719+1	444	444	1000	50	50				

TABLE 6 (a) Cont'd

HOMOGENEOUS - MISCELLANEOUS (AXS-54, Revs. F, H, K, etc.)						Calibre .30	
Thickness	Manufacturer	Chemical Composition	Arithmetic Means		Optimum Averages Ballistic Limits	Specification Averages Ballistic Limits	Plates Passing British Standards
			Rev.	Limits			
.1/2"	500	Diston	Cr-Mo-Va	H	2497	-	2497
"	"	"	"	K	2609	-	2609

Calibre .50

.5/8"	.625	Diston	Cr-Mo-Va	H	1743	-	1763
"	"	"	"	K	2120	-	2120+3
.3/4"	.75	Diston	Cr-Mo-Va	K	2356	-	2356+5
.7/8"	.875	Diston	Cr-Mo-Va	H	2500	-	2500

TABLE 6 (b)
CARBURIZED - Spec. 150; - Calibre .30

Thickness	Manufacturer	Chemical Composition	Arithmetical Means			Optimum Averages			Specification		
			Ballistic Brinells	Front Back	Limits	Ballistic Brinells	Front Back	Limits	Ballistic Brinells	Front Back	Weight
1/16" .25	Halcomb	Ni-Cr	1892	490	-	2017	536	-	2017+120	536	-
5/16" .313	Halcomb	Ni-Cr	2209	590	-				2219+22	590	-
3/8"	375 Carnegie	-	2481	600	444				2481	600	444
"	Crucible	Cr-Mo-Ni-Si	2371	570	570				-	-	0
"	"	Cr-Mo-Ni-Si-Va-W	2211	555	555				2211	555	555
"	"	Co-Cr-Mo-Si-Va-W	2155	600	600				-	-	0
"	"	Co-Cr-Mo-Si-Va-W	2040	555	555				-	-	0
Halcomb	Ni-Cr	2188	529	-		2293	566		2293+46	566	-
7/16" .438	Halcomb	Ni-Cr	2347	590	-				2347+21	590	-
1/2"	.500 Maston Halcomb	Cr-Mo-Va Ni-Cr	2706	553	510				2650	555	477
			2573	590	-				2567+30	590	-
									100	92	88

TABLE 6 (b) Cont'd

CARBURIZED - Spec. 150; - Calibre .50

Thickness	Manufacturer	Chemical Composition	Arithmetic Means				Optimum Averages				Specification				% of Plates Passing Brittle Spec. Plate
			Ballistic Brinell	Front Limit	Back Limit	Ballistic Brinell	Front Back	Front Back	Front Back	Front Back	Weight				
3/8"	.375 Carnegie	-	1572	652	477							0			100
	Crucible	Cr-Mo-Ni-Si	2089	600	600							0			100
	"	Co-Cr-Mo-Si	2318	555	555							0			100
1/2"	.500 Carnegie	-	2200	600	512							0			100
	Dissston	Cr-Mo-Va	2044	566	499	2194	570	495				0			100
	Halcomb	Ni-Cr	2032	590	-	-	-	-	2025±20	590	-	143			17
3/4"	.75 Crucible	Cr-Mo	2215	537	283	2249	557	278	2244±60	557	278	67	77	0	
	Halcomb	Ni-Cr	2192	537	-	2239	563	-	2239±52	563	-	91	53	6	
7/8"	.875 Carnegie	-	2569	600	280							0			100
1"	1.00 Carnegie	-	2495	-	-							-	333	33	0

No specifications for these thicknesses.

TABLE 6 (b) Cont'd
CARBURIZED - Spec. 311 Calibre .30

Specification										% of Plates Passing Brit. Spec.		P.L.		
Averages														
Ballistic Brinell's														
Optimum Averages														
Thickness	Manufacturer	Chemical Composition	Arithmetic Means	Ballistic Brinell's	Front	Back	Front	Back	Front	Back	Front	Back	P.L.	
1/8"	.125	Dulston	Cr-Mo-Va	1148	391	1180	447	400	1159+56	136	398	45	0	
1/4"	.25	Carnegie	-	2015	541	541	-	-	2004	555	555	260	67	
		Dulston	Cr-Mo-Va	1815	481	389	2020	510	413	1994+116	497	399	31	41
3/8"	.375	Carnegie	-	2179	555	555	-	-	-	-	-	0	0	
		Dulston	Cr-Mo-Va	2295	502	400	2171	511	395	2371+104	511	395	28	85
1/2"	.500	Dulston	Cr-Mo-Va	2765	517	366	2890	535	392	2836+97	518	384	34	73
<u>Spec. 311 Calibre .50</u>														
1/4"	.25	Dulston	Cr-Mo-Va	1178	518	431	-	-	1175+34	499	428	29	29	
3/8"	.375	Dulston	Cr-Mo-Va	1846	555	417	-	-	-	-	-	0	0	
1/2"	.500	Carnegie	-	2152	555	544	-	-	-	-	-	0	0	
3/4"	.75	Carnegie	-	2159	533	533	-	-	-	-	-	0	0	
"	1.00	Carnegie	-	2847	532	505	-	-	-	2847+8	532	505	125	100

No Specs.
for these
thicknesses.

No Specs.
for these
thicknesses.

TABLE 6 (b) Cont'd
CATEGORIZED - Spec. AXS-54-1; Calibre .30

Thickness	Manufacturer	Chemical Composition	Arithmetical Means				Optimum Averages				Specification			
			Ballistic Brinell		Ballistic Brinell		Ballistic Brinells		Ballistic Brinells		Averages			
			Front	Back	Front	Back	Front	Back	Front	Back	Front	Back	Front	Back
1/4" .25	Carnegie	-	1998	541	2016	555	2016+12	555	53	67	67	67	53	53
	Disston	Cr-Mo-Va	1626	454	364	1808	467	387	1813+101	466	386	29	18	14
3/8" .375	Carnegie	-	2172	555	-	-	-	-	-	-	0	0	0	100
	Disston	Cr-Mo-Va	1974	470	389	2114	465	382	2114+191	465	382	11	17	8
1/2" .500	Disston	Cr-Mo-Va	2348	468	336	2476	470	371	2476+117	470	371	23	45	0
			<u>Spec. AXS-54-1; Calibre .30</u>				<u>Spec. AXS-54-1; Calibre .50</u>							
1/2" .500	Carnegie	-	2152	555	514	-	-	-	-	-	-	0	No Spec.	100
	Disston	Cr-Mo-Va	1911	-	-	-	-	-	1941+115	-	-	9	Spec.	0
3/4" .75	Carnegie	-	2049	533	533	-	-	-	-	-	0	0	0	100
1" 1.00	Carnegie	-	2758	532	505	-	-	-	2758+97	532	505	10	100	0
			<u>Spec. AXS-54-2; Calibre .30</u>				<u>Spec. AXS-54-2; Calibre .50</u>							
1/4" .25	Disston	Cr-Mo-Va	1987	-	-	-	-	-	1987+4	-	-	250	100	0
1/2" .500	Disston	Cr-Mo-Va	2683	-	-	-	-	-	2683	-	-	1	100	0
1" 1.00	Disston	Cr-Mo-Va	2936	-	-	-	-	-	2936	-	-	1	100	0

TABLE 6 (b) Cont'd

CARBURIZED - Spec. AXS-54 (T, H, K, etc.); Calibre : 30

Spec. No.	Chemical Composition	Manufacturer	Composition Rev.	Cr-Mo-Va	H	1921	Averages			Specification		
							Front Back	Limts	Brinell	Front Back	Limts	Brinell
5/16". 188	Diastion	Diebold	.25	Diebold	-	F	2022	2022+50	2022-50	22	100	C
5/16". 313	Diastion	Cr-Mo-Va	-	Diebold	-	F	2018	2018	2018	1	100	C
3/8". 375	Diebold	-	-	Diebold	-	F	2085	2266+54	2266-54	1	100	C
7/16". 438	Diebold	-	-	Diebold	-	F	2471	2525+23	2525-23	19	100	C
1 1/2". 500	Diebold	-	-	Diebold	-	F	2456	2693	2693	1	100	C
9/16". 563	Diebold	-	-	Diebold	-	F	2700	2700+13	2700-13	77	No Spec.	C
<u>Spec. A725-54 - (P, H, L, etc.); Calibre .50</u>												
5/8". 625	Diebold	-	-	Diebold	-	F	2148	2148+6	2148-6	167	100	C
3/4". 75	Diebold	-	-	Diebold	-	F	2310	2310	2310	1	100	C
1". 1.00	Diebold	-	-	Diebold	-	F	2609	2609	2609	1	100	C
<u>Spec. A725-54 - (P, H, L, etc.); Calibre .50</u>												
10	100	Diastion	Cr-Mo-Va	-	-	F	2667+102	2667+102	2667+102	1	100	C

TABLE 6 (c)

MITSIDED - Spec. 150; - Calibre .30

Thickness	Manufacturer	Chemical Composition	Arithmetic Means		Optimum Averages		Ballistic Brinells		Ballistic Brinells		Specification		% of Plates Passing Spec.	% of Plates Dritt'l Plate
			Brinell	Front Back	Brinell	Front Back	Brinell	Front Back	Brinell	Front Back	Brinell	Front Back		
1/4"	.25	Ludlum	1836	466	1696	473	1886	76	166	334	19	33	0	0
7/16"	.438	Ludlum	2431	455	318	-	2431	455	318	34	100	0	0	0
<u>Spec. 31 - Calibre .30</u>														
1/8"	.125	Edystone	1298	457	1298	457	1298	457	1298	457	33	0	0	0
3/16"	.188	"	"	1326	466	1696	473	1750	20	477	12	33	50	50
1/4"	.25	"	"	2016	466	2059	471	2039	50	471	40	100	0	0
3/8"	.375	"	"	2394	466	-	-	2364	68	477	15	67	33	33
1/2"	.500	"	"	2566	461	-	-	2566	86	461	20	100	0	0
1/2"	.500	"	"	1903	455	1903	455	1783	21	455	1000	No Spec.	33	33
5/8"	.625	"	"	2357	461	-	-	2357	461	-	-	0	0	100
3/4"	.75	"	"	2524	461	-	-	2524	461	-	-	0	0	100
1"	1.00	"	"	2674	455	-	-	2674	455	-	-	0	0	100
1/4"	.25	T.A.E.P.	-	-	2033	-	2033	-	2100	50	-	2.8	83	17
3/8"	.375	"	"	-	-	1913	-	1913	-	-	-	16	50	0
7/16"	.438	"	"	-	-	2275	-	2275	-	-	-	1	100	0
1/2"	.500	"	"	2331	-	2331	-	2350	-	10	75	0	0	0

TABLE 7 (a) - WEIGHTED MEANS OF SPECIFICATION AVERAGES

HOMOGENEOUS

Thickness	Weighted Mean of Ballistic Limit	Weight
<u>Spec. 150 - Calibre .30</u>		
3/16" - .188	1454	5
1/4" - .25	1801 \pm 12	11
5/16" - .313	2031 \pm 7	10
3/8" - .375	2265 \pm 29	18
7/16" - .438	2584 \pm 4	11
1/2" - .500	2710 \pm 33	8
<u>Spec. 150 - Calibre .50</u>		
1/2" - .500	1756 \pm 25	1
5/8" - .625	1835 \pm 28	1
3/4" - .75	2266 \pm 5	2
<u>Spec. 31 - Calibre .30</u>		
1/8" - .125	1021 \pm 23	1
3/16" - .188	1526 \pm 18	1
1/4" - .25	1799 \pm 31	2
5/16" - .313	2128	0
3/8" - .375	2279 \pm 31	2
7/16" - .438	2561 \pm 16	1
1/2" - .500	2677 \pm 43	1
<u>Spec. 31 - Calibre .50</u>		
1/2" - .500	1900 \pm 59	.3
5/8" - .625	2325	0
3/4" - .75	2539	0
1" - 1.00	2669 \pm 100	.1
<u>Spec. AXS54-Rev. 1 - Calibre .30</u>		
3/16" - .188	922 \pm 27	0
1/4" - .25	1311 \pm 65	1
3/8" - .375	1770 \pm 27	1
1/2" - .500	2373 \pm 51	1
<u>Spec. AXS54-Rev. 1 - Calibre .50</u>		
1/2" - .500	1826	0
<u>Spec. AXS54-Rev. 2 - Calibre .30</u>		
1/2" - .500	2719 \pm 1	10

TABLE 7 (e) Cont'd

HOMOGENEOUS

Thickness	Weighted Mean of Ballistic Limit	Weight
	Spec. AXS54- Revs. F, H, K, etc. - Calibre .30	
1/2" - .500	2553	.2
	Spec. AXS54- Revs. F, H, K, etc. - Calibre .50	
5/8" - .625	2100 ⁺³	3
3/4" - .75	255 ⁺⁶	2
7/8" - .875	2366 ← 2500	.1

TABLE 7 (b) - WEIGHTED MEANS OF SPECIFICATION AVERAGES
CALCULATED

<u>Thickness</u>	<u>Weighted Mean of Ballistic Limit</u>	<u>Weight</u>	
<u>Spec. 150 - Calibre .30</u>			
1/4"	- .25	2017+100	0.0
5/16"	- .313	2219+28	1.0
3/8"	- .375	2294+45	1.0
7/16"	- .438	2347+21	1.0
1, 9"	- .500	2509+30	1.0
<u>Spec. 150 - Calibre .50</u>			
1/2"	- .500	2025+30	1.0
3/4"	- .75	2244+56	2.0
1"	-1.00	2495+4	3.0
<u>Spec. 31 - Calibre .30</u>			
1/8"	- .125	1159+36	1.0
1/4"	- .25	2035+16	3.0
3/8"	- .375	2371+104	0.2
1/2"	- .500	2638+97	0.3
<u>Spec. 31 - Calibre .50</u>			
1/4"	- .25	1175+34	0.2
1/2"	- .500	2165+59	0.2
1"	-1.00	2847+6	1.0
<u>Spec. AXS54-Rev. 1 - Calibre .30</u>			
1/4"	- .25	1962+36	1.0
3/8"	- .375	2114+194	0.1
1/2"	- .500	2476+117	0.2
<u>Spec. AXS54-Rev. 1 - Calibre .50</u>			
1/2"	- .500	1941+15	0.1
1"	-1.00	2758+97	0.1
<u>Spec. AXS54-Rev. 2 - Calibre .30</u>			
1/4"	- .25	1927+4	3.0
1/2"	- .500	2683	0.0
<u>Spec. AXS54-Rev. 2 - Calibre .50</u>			
1"	-1.00	2936	0.0
1 1/4"-1.25		2941	0.0

TABLE 2 (a) cont'd

UNARMED

<u>Thickness</u>	<u>Spec. A.M.S.C4-Pevs. F, H, K - Calibre .30</u>	<u>Weight</u>
3/10" - .182	1801	2
1/4" - .25	2002+50	0
5/10" - .312	2083	0
3/5" - .375	2276+54	0
7/10" - .438	2505+25	1
1/2" - .500	2696	0
3/10" - .563	2700+15	1
<u>Spec. A.M.S.C4-Pevs. F, H, K - Calibre .50</u>		
5/8" - .625	3148+6	2
3/4" - .75	2310	0
1" - 1.00	2571+102	0
1 1/8"-1.13	2706	0
1 1/4"-1.25	2847	0

TABLE 7 (c) - WEIGHTED MEANS OF SPECIFICATION AVERAGES
WITNESSED

<u>Thickness</u>	<u>Weighted Mean of Ballistic Limit</u>	<u>Weight</u>
	<u>Spec. 150 - Calibre .30</u>	
1/4" - .25	1996±76	2
7/16" - .438	2481±21	3
	<u>Spec. 31 - Calibre .30</u>	
1/8" - .125	1230±43	3
3/16" - .188	1750±100	1
1/4" - .25	2039±50	4
3/8" - .375	2364±62	2
1/2" - .500	2566±86	2
	<u>Spec. 31 - Calibre .50</u>	
1/2" - .500	1783±1	100
	<u>Spec. AX554-Rev. 2 - Calibre .30</u>	
1/4" - .25	2100±50	3
3/8" - .375	1913±63	2
7/16" - .438	2275±	0
1/2" - .500	2450±100	1
(Too meager and erratic to plot successfully)		

TABLE 6 (a) - BALLISTIC EFFICIENCY OF HOMOGENEOUS PLATE

HOMOGENEOUS

CRUCIBLE

<u>Thickness</u>	<u>Chemical Composition</u>	<u>Passed</u>	<u>Brittle</u>
<u>Spec. 150 - Calibre .30</u>			
1/4" .25	Cr-Lo	0	67
5/16" .313	Cr-Lo	0	33
3/8" .375	Cr-Lo	64	29
7/16" .437	-	0	100
1/2" .500	-	100	0
<u>Spec. 150 - Calibre .50</u>			
3/4" .75	-	40	60
Grand Average		34	48
<u>Spec. 31 - Calibre .30</u>			
1/4" .25	Cr-Lo	0	100
<u>Spec. AXS54-Rev. 1 - Cal. .30</u>			
1/4" .25	Cr-Lo	0	100
Grand Average		0	100

TABLE I (a) Cont'd

<u>Thickness</u>	<u>Calibre .50</u>	<u>Passed</u>	<u>Brittle</u>
1/4" .25	Straight C Ni-Cr Ni-Mo Ni-Si Ni-Va	78 100 100 0 0	22 0 0 100 100
5/16" .313	Straight C Ni-Cr Ni-Mo Ni-Si Ni-Va	100 100 100 100 100	0 0 0 0 0
3/8" .375	Straight C Ni-Cr Ni-Mo Ni-Si Ni-Va Mn-Ni-Va	100 100 100 100 100 0	0 0 0 0 0 0
7/16" .438	Straight C Ni-Cr Ni-Mo Ni-Si Ni-Va	0 100 100 100 100	0 0 0 0 0
1/2" .500	Straight C Ni-Cr Ni-Mo Ni-Si Ni-Va Cr-Mo-Va	67 100 100 100 100 100	0 0 0 0 0 0
5/8" .625	Cr-Mo-Va	14	71
	Grand Average	81	10

TABLE 6 (a) Cont'd

DISSTOR HOMOGENEITY

<u>Thickness</u>	<u>Chemical Composition</u>	<u>Passed</u>	<u>Brittle</u>
<u>Spec. 31 - Calibre .30</u>			
3/16" .138	Cr-Mo-Ve	00	0
1/4" .25	"	71	13
5/16" .313	"	100	0
3/8" .375	"	87	13
7/16" .438	"	100	0
1/2" .500	"	75	25
<u>Spec. 31 - Calibre .50</u>			
5/8" .625	Cr-Mo-Ve	100	0
3/4" .75	"	50	50
1" 1.00	"	100	0
Grand Average			
		83	11
<u>Spec. AXS54-Rev. 1 - Calibre .30</u>			
3/16" .138	Cr-Mo-Ve	0	0
1/4" .25	"	0	8
3/8" .375	"	0	25
1/2" .500	"	7	7
<u>Spec. AXS54-Rev. 1 - Calibre .50</u>			
3/4" .75	Cr-Mo-Va	0	100
1" 1.00	"	0	100
Grand Average			
		1	40
<u>Spec. AXS54-Rev. 2 - Calibre .50</u>			
1/4" .25	Cr-Mo-Va	0	100
3/8" .375	"	0	100
1/2" .500	"	50	50
Grand Average			
		17	83
<u>Spec. AXS54-Revs. H & K - Calibre .50</u>			
5/8" .625	Cr-Mo-Va	(0 100	(50 0
3/4" .75	"	100	0
7/8" .875	"	100	0
Grand Average			
		75	13

TABLE 6 (a) Cont'd

EDDYSTONEHOMOGENEOUS

<u>Thickness</u>	<u>Chemical Composit' on</u>	<u>% Passed</u>	<u>% Brittle</u>
<u>Spec. 150 - Calibre .30</u>			
3/16" .183	Cr-Ve	0	0
<u>Spec. 51 - Calibre .30</u>			
3/16" .188	Cr-Mo-Ve	100	0
1/4" .25	"	60	40
3/8" .375	"	44	56
1/2" .500	"	100	0
Grand Average		76	24

TABLE 6 (b) - BALLISTIC EFFICIENCY OF CARBURIZED PLATE

CARNEGIE

<u>Thickness</u>	<u>Chemical Composition</u>	<u>% Passed</u>	<u>% Brittle</u>
<u>Spec. 150 - Calibre .30</u>			
3/8" .375	-	100	0
<u>Spec. 150 - Calibre .30</u>			
7/8" .675	-	0	100
1" 1.00	-	33	0
GRAND AVERAGE		44	33
<u>Spec. 31 - Calibre .30</u>			
1/4" .25	-	67	33
3/8" .375	-	0	100
<u>Spec. 31 - Calibre .50</u>			
3/4" .75	-	0	100
1" 1.00	-	100	0
GRAND AVERAGE		42	58
<u>Spec. AXS54-Rev. 1 - Calibre .30</u>			
1/4" .25	-	67	33
3/8" .375	-	0	100
<u>Spec. AXS54-Rev. 1 - Calibre .50</u>			
3/4" .75	-	0	100
1" 1.00	-	100	0
GRAND AVERAGE		42	58

TABLE 8 (b) Cont'd

CRUCIBLECARBURIZED - Spec. 150

<u>Thickness</u>	<u>Chemical Composition</u>	<u>% Passed</u>	<u>% Brittle</u>
<u>Calibre .30</u>			
3/8" .375	Cr-Mo-W-Si	0	100
	W-Si-Cr-Mo-W	100	0
	Co-Cr-Mo-Si-Va-W	0	100
	Co-Cr-Mo-Si	0	100
<u>Calibre .50</u>			
3/4" .75	Cr-Mo	77	0
<u>Grand Average</u>			
		35	60

TABLE C (b) Cont'd

DIEBOLDCARBURIZEDSpec. AXS54-Revs. F, H, & K

<u>Thickness</u>	<u>Chemical Composition</u>	<u>% Passed</u>	<u>% Brittle</u>
<u>Calibre .30</u>			
1/4" .35	-	100	0
5/16" .313	-	100	0
3/8" .375	-	100	0
7/16" .438	-	100	0
1/2" .500	-	100	0
<u>Calibre .50</u>			
9/16" .563	-	100	0
5/8" .625	-	100	0
3/4" .75	-	100	0
1" 1.00	-	100	0
GRAND AVERAGE		100	0

TABLE 2 (b) Cont'd

DISSTONCAPBURIZED

<u>Thickness</u>	<u>Chemical Composition</u>	<u>% Passed</u>	<u>% Brittle</u>	
1/2"	<u>.500</u>	<u>Spec. 150 - Calibre .30</u> Cr-Mo-Va	<u>12</u>	<u>88</u>
1/3"	<u>.125</u>	<u>Spec. 31 - Calibre .30</u> Cr-Mo-Va	<u>0</u>	<u>53</u>
1/4"	<u>.25</u>	<u>"</u>	<u>41</u>	<u>16</u>
3/8"	<u>.375</u>	<u>"</u>	<u>85</u>	<u>5</u>
1/2"	<u>.500</u>	<u>"</u>	<u>73</u>	<u>19</u>
<u>Grand Average</u>		<u>50</u>	<u>18</u>	
1/4"	<u>.25</u>	<u>Spec. AXS54-Rev. 1 - Calibre .30</u> Cr-Mo-Va	<u>18</u>	<u>14</u>
5/8"	<u>.375</u>	<u>"</u>	<u>17</u>	<u>8</u>
1/2"	<u>.500</u>	<u>"</u>	<u>45</u>	<u>0</u>
<u>Grand Average</u>		<u>27</u>	<u>7</u>	
1/4"	<u>.25</u>	<u>Spec. AXS54-Rev. 2 - Calibre .30</u> Cr-Mo-Va	<u>100</u>	<u>0</u>
1/2"	<u>.500</u>	<u>"</u>	<u>100</u>	<u>0</u>
1"	<u>1.00</u>	<u>Spec. AXS54-Rev. 2 - Calibre .50</u> Cr-Mo-Va	<u>100</u>	<u>0</u>
<u>Grand Average</u>		<u>100</u>	<u>0</u>	
1/4"	<u>.25</u>	<u>Spec. AXS54-Revs. F, H, & K, Cal. .30</u> Cr-Mo-Va	<u>100</u>	<u>0</u>
3/8"	<u>.375</u>	<u>"</u>	<u>100</u>	<u>0</u>
1"	<u>1.00</u>	<u>Spec. AXS54-Revs. F, H, & K, Cal. .50</u> Cr-Mo-Va	<u>100</u>	<u>0</u>
<u>Grand Average</u>		<u>100</u>	<u>0</u>	

TABLE 9 (b) Cont'd

HALCOLECARBURIZED - Spec. 150

<u>Thickness</u>	<u>Chemical Composition</u>	<u>Passed</u>	<u>Brittle</u>
<u>Calibre .30</u>			
1/4" .25	Mn-Cr	69	0
5/16" .313	"	100	0
3/8" .375	"	52	0
7/16" .438	"	92	8
1/2" .500	"	92	8
<u>Calibre .50</u>			
5/8" .75	Mn-Cr	55	6
Grand Average		80	4

TABLE 6 (c) - BALLISTIC EFFICIENCY OF NITRIDED PLATE

<u>Thickness</u>	<u>Chemical Composition</u>	<u>% Passed</u>	<u>% Brittle</u>
<u>LUDLUM - Spec. 150 - Calibre .30</u>			
1/4" .25	Cr-Vo-Al	33	0
7/16" .458	"	100	0
Grand Average		67	0
<u>EDDYSTONE - Spec. 31 - Calibre .30</u>			
1/8" .125	Cr-Va	0	0
3/16" .188	Cr-Va	33	50
1/4" .25	"	100	0
3/8" .375	"	67	33
1/2" .500	"	100	0
<u>EDDYSTONE - Spec. 31 - Calibre .30</u>			
5/8" .325	Cr-Va	0	100
3/4" .75	"	0	100
1" 1.00	"	0	100
Grand Average		36	48
<u>WATERTOWN ARSENAL EXPERIMENTAL</u>			
<u>Spec. AXS54-Rev. 2 - Calibre .30</u>			
1/4" .25		83	17
3/8" .375		50	0
7/16" .458		100	0
1/2" .500		75	0
Grand Average		77	4

TABLE 9

MOLDED ARMOR
SUBSTITUTED NICKEL SHEET

.30/.40 .50/.60 8.25/8.75

: Spec. AXS-54, Rev. 2 : Spec. AXS-54, Rev. 2,
: AXS-54E, S : Rev. E.T.A., 1/11/36

Thickness	As Rolled		Heat Treated		As Rolled		Heat Treated	
	Harc.	S. I.	Harc.	S. I.	Harc.	S. I.	Harc.	S. I.
.1/8" .075 :	187	1431	321	1720	187	1833	321	2130
.1/4" .25 :	196	1113	302	1193	196	1608	302	1765
.3/8" .375 :	179	1497	286	1837	183	1914	286	2274
.1/2" .500 :	179	1837	269	2144	179	2157	269	2433
.5/8" .625 :	187	1408	269	1590	187	1839	269	2067
.3/4" .75 :	179	1592	262	1762	179	1965	262	2190
.7/8" .875 :	187	1851	311	2081	187	2110	311	2407
1" 1.00 :	196	2032	286	2281	196	2276	286	2546
.1/4" .25 :		351	1186				351	1698
.3/8" .375 :		351	1769				351	2145
.1/2" .500 :		364	2424				364	2567
.5/8" .625 :		351	1622				351	2072
.3/4" .75 :		351	1965				351	2304
.7/8" .875 :		351	2093				351	2502
1" 1.00 :		364	2446				364	2737

Calibre .30 M1922 - A.P.

1/4" .25 :	1113	1193	1508	1765
3/8" .375 :	1431	1720	1833	2130
.1/2" .500 :	(1497	(1837	(1914	(2274

Calibre .50 M1 - A.P.

5/8" .625 :	1408	1590	1839	2067
3/4" .75 :	1592	1762	1965	2190
.7/8" .875 :	1851	2081	2110	2407
1" 1.00 :	2032	2281	2276	2546

TABLE 10 (a)
 CHEMICAL COMPOSITION AND DRAW TEMPERATURE
 VS
 DRAW TEMPERATURE

FOR DISSTON HOMOGENEOUS 1/4" PLATE

Spec. 150 - Calibre .30 - 150 grain bullet, 73 grain core.

Chemical Composition	Heat Treatment			Ballistic Limit f. s.
	Quench °F	In	Draw °F	
Carbon	1450	H ₂ O	495	1300
	"	"	650	1391
	"	"	710	1837
	"	"	790	1760
	"	"	900	1764
	"	"	1000	1726
	"	"	1090	1644
	"	"	1245	1510
Ni-Mo	1500	Oil	495	1125
	"	"	650	1774
	"	"	710	1831
	"	"	790	1824
	"	"	900	1855
	"	"	1000	1871
	"	"	1090	1798
	"	"	1245	1741
Ni-Va	1500	Oil	495	1560
	"	"	650	1651
	"	"	710	1842
	"	"	790	1818
	"	"	900	1735
	"	"	1000	1691
	"	"	1055	1748
	"	"	1245	1686
Ni-Cr	1500	Oil	495	1565
	"	"	650	1534
	"	"	710	1555
	"	"	790	1844
	"	"	900	1787
	"	"	1000	1772
	"	"	1095	1756
	"	"	1245	1705

TABLE 10 (a) Cont'd

FOR DISSTON HOMOGENEUS 1/4" PLATE

<u>Chemical Composition</u>	<u>Heat Treatment</u>			<u>Ballistic Limit f. s.</u>
	<u>Quench °F</u>	<u>In "</u>	<u>Draw °F</u>	
Ni-Si	1475	Oil	495	1248
"	"	"	650	1282
"	"	"	710	1286
"	"	"	790	1451
"	"	"	900	1595
"	"	"	1000	1519
"	"	"	1095	1771
"	"	"	1245	1736

CHEMICAL COMPOSITION AND DRAW TEMPERATURE
 VS
DRAW TEMPERATURE

FOR DISSTCH HOMOGENEOUS S-2 PLATE

Spec. 150 - Calibre .30 - 150 Grain bullet, 73 Grain core.

Chemical Composition	Heat Treatment			Ballistic Limit I. S.
	Quench °F	In H ₂ O	Draw °F	
Caroon	1455	H ₂ O	510	2253
"	"	"	640	2243
"	"	"	740	2207
"	"	"	835	2304
"	"	"	925	2194
"	"	"	995	2100
"	"	"	1105	2134
"	"	"	1210	2097
Ni-Lo	1505	Oil	510	2151
"	"	"	640	2146
"	"	"	740	2267
"	"	"	835	2371
"	"	"	925	2381
"	"	"	995	2355
"	"	"	1105	2370
"	"	"	1210	2236
Ni-Va	1505	Oil	510	2372
"	"	"	640	2379
"	"	"	740	2360
"	"	"	835	2252
"	"	"	925	2157
"	"	"	995	2216
"	"	"	1105	2102
"	"	"	1210	2104
Ni-Cr	1510	Oil	510	2088
"	"	"	640	2091
"	"	"	740	2154
"	"	"	835	2337
"	"	"	925	2240
"	"	"	995	2260
"	"	"	1105	2162
"	"	"	1210	2144
Ni-Si	1480	Oil	510	2042
"	"	"	640	2047
"	"	"	740	2078
"	"	"	835	2156
"	"	"	925	2143
"	"	"	995	2272
"	"	"	1105	2228
"	"	"	1210	2174

TABLE 10 (c)
 CHEMICAL COMPOSITION AND DRAW TEMPERATURE
 VS
 DRAW TEMPERATURE
FOR DISSTON HOMOGENEOUS 1/2" PLATE

Spec. 150 - Calibre .30 - 150 grain bullet, 73 grain core.

Chemical Composition	Heat Treatment			Ballistic Limit f. s.
	Quench °F	In H ₂ O	Draw °F	
Carbon	1460	H ₂ O	495	2675
"	"	"	630	2697
"	"	"	755	2688
"	"	"	845	2504
"	"	"	940	2684
"	"	"	1030	2526
"	"	"	1125	2364
"	"	"	1220	2357
Ni-Mo	1510	Oil	495	2717
"	"	"	630	2827
"	"	"	755	2931
"	"	"	845	2858
"	"	"	940	2873
"	"	"	1030	2684
"	"	"	1125	2717
"	"	"	1220	2657
Ni-Va	1515	Oil	495	2746
"	"	"	630	2709
"	"	"	755	2737
"	"	"	845	2557
"	"	"	940	2549
"	"	"	1030	2561
"	"	"	1125	2550
"	"	"	1220	2491
Ni-Cr	1510	Oil	495	2744
"	"	"	630	2744
"	"	"	755	2734
"	"	"	845	2690
"	"	"	940	2625
"	"	"	1030	2593
"	"	"	1125	2564
"	"	"	1220	2449
Ni-Si	1485	Oil	495	2742
"	"	"	630	2791
"	"	"	755	2833
"	"	"	845	2837
"	"	"	940	2774
"	"	"	1030	2696
"	"	"	1125	2569
"	"	"	1220	2528

TABLE II (a)
CHEMICAL COMPOSITIONS OF VARIOUS MANUFACTURERS
OF HOMOGENEOUS PLATE

Manufacturer	Type	Chemical Analysis (General Limits)					
		C	Mn	Si	Ni	Cr	Mo
Dissston	Straight, Carbon	.495/.470	.74/.63	.16	-	-	-
	Ni-Cr	.41/.40	-	-	3.39/3.37	1.35/1.30	-
	Ni-Mo	.485/.370	-	-	4.55/4.35	-	-
	Ni-Si	.52/.38	-	1.93/1.76	3.09/2.97	1.28/.36	-
	Ni-Va	.36/.30	-	-	3.20/3.11	-	1.04/.23
	Ni-Ni-Va	.35/.30	1.0	-	3.2/3.1	-	.35
	Ni	.40	-	-	4.60	-	-
	Ni-Mn	.36	1.02	-	-	-	-
	Ni-Ni-Si	.43/.33	1.10/1.02	2.05/1.63	3.17	-	-
	Ni-Mo-Ni	.39	1.02	-	3.24	-	-
	Cr-Mo-Va	.55/.29	-	-	-	1.36/1.00	.86/.56
Eddystone	Cr-Mo-Va	.50	-	-	-	1.10	.60
	Cr-Va	.45	-	-	-	1.10	.25
	Co	-	-	-	-	-	.25

TABLE II (b)

CHEMICAL COMPOSITIONS OF VARIOUS MANUFACTURERS
OF CARBURIZED PLATE

Manufacturer	Type	C	Mn	Si	Chemical Analysis (General Limits)			
					Ni	Cr	Va	Co
Carnegie	No analysis furnished.							
Crucible	Cr-Mo-Ni-Si	.36/.35	-	1.60	3.62/3.25	.71/.60	.32/.37	-
	Cr-Mo-Ni-Si-Va-W	.60/.50	-	2.00/1.75	3.25/3.00	.70/.60	.50/.50	.39/.20
	Co-Cr-Mo-Si-Va-W	.55/.45	-	1.75/1.50	-	.70/.60	.40/.30	.30/.20
	Cr-Mo	.50	-	-	-	.90	.28	.25/.20
Diebold	No analysis furnished.							
Dissston	Cr-Mo-Va	.26/.23	-	-	-	1.36/1.00	.86/.55	.30/.20
Halcomb	Ni-Cr	.14	-	-	1.15	1.43	-	-

TABLE II (c)

**CHEMICAL COMPOSITIONS OF VARIOUS MANUFACTURERS
OF NITRIDED PLATE**

Manufacture	Pallstone	Cr-Va	Cr-Mo-Al	DeMarre	Coefficient	Chemical Analysis (General Units)						A1
						C	Mn	Si	Ni	Cr	Tu	
Ludlum			1.043	.36	-	-	-	-	1.49	.18	-	1.23
									1.20	-	.28	-
V. A.	Cr-Mo-Ve-Al-Ni	1.513	.450/.445	-	-	3.31/3.23	1.20	.51/.60	27/.255	1.00/.55		
Experimental	Cr-Mo-Ve-Ni	1.286	.56/.525	-	-	3.09	1.24	.76/.72	.255/.24	1.19/.21		
	Cr-Mo-Ve-Al	1.451	.56/.39	-	-	-	3.50/1.26	.76/.53	.255/.21	1.19/.11		
	Cr-Mo-Va	2.002	.50	-	-	-	1.09	.72	.27			